



# **Trans-Lake Washington Project**

Washington State  
Department of Transportation  
Sound Transit

## **FINAL DRAFT TECHNICAL MEMORANDUM**

### **PRICING AND MANAGED LANES Trans-Lake Washington Corridors**

#### **INTRODUCTION**

The purpose of this memorandum is to provide technical information on the performance and evaluation of the transportation pricing and managed lane alternatives analyses for the Trans-Lake corridors. Much of this memorandum focuses on the three build alternatives currently being evaluated by the Trans-Lake Washington project, and how they interact with the I-90 corridor.

- Safety and Preservation Alternative (4 Lane Alternative)
- Added HOV Lane Alternative (6 Lane Alternative)
- Added HOV and GP Lanes Alternative (8 Lane Alternative)

Each of these alternatives were evaluated at a corridor level, under the assumption that the potential for a regional system of managed lanes and/or transportation pricing program may become part of a long-range plan for the Central Puget Sound Region. This is consistent with the Puget Sound Regional Council (PSRC) policy framework outlined in the “Destination 2030” regional plan.

This memorandum is organized into four sections. The first section of this memorandum presents a general description of the transportation pricing and managed lane alternatives that were modeled for the Trans-Lake corridor. The second section describes the modeling methodologies that were used in modeling the transportation pricing and managed lane alternatives, and includes the estimation of toll rates and revenue estimates for the Trans-Lake corridor. The third section describes and presents the performance of the transportation pricing and managed lanes alternatives. The fourth and final section provides conclusions from the analysis, and provides recommendations for the next steps to define a pricing and/or managed lane option for the SR 520 corridor.

#### **TRANS-LAKE MANAGED LANE AND TRANSPORTATION PRICING ALTERNATIVES**

A total of seven alternatives were modeled using PSRC’s suite of travel demand models. Six of these were transportation pricing alternatives, while the seventh was a managed lane alternative.

##### **Transportation Pricing Alternatives**

The concept of Value Pricing, also known as peak period pricing has been used in this study. It entails tolls or user fees that vary with the level of congestion on a facility. The more congested a facility is, the higher is the toll or user fee to use that facility. The more expensive the toll, the lower will be the number of users willing to pay the toll, thereby managing congestion on the facility.

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Road user fees or tolls that vary with the level of congestion provide incentives to shift some trips to less congested routes (local arterials), or alternative modes (carpooling and transit), or trip chaining (combining trips), or eliminate the trip, or shift the trip to off-peak period times. Since, off-peak period is also tolled in our study, this shift would not occur in our analysis.

Value pricing can be implemented only with Electronic Toll Collection (ETC) technology. The user fees or tolls can change every five minutes, with enough lead time such that a traveler knows exactly how much will be charged upon entry to a facility. This option has become technically viable within the last few years, as applications in California (SR 91 and I-15) have successfully demonstrated.

The following provides a description of the six transportation pricing alternatives that were modeled using the toll estimation methodology described in the following section of this memorandum.

#### **Safety and Preservation Alternative - 4 Lanes**

1. **4 Lane Value Pricing Concept – Toll on SR 520:** AM, PM and Off Peak period value pricing on SR 520 from SR 202 to I-5. All users (SOV and HOV 3+) with the exception of transit will be subject to tolls. Since SOV and HOV users share the same lanes and are not physically separated, the value pricing modeling methodology used to estimate toll rates cannot differentiate between SOV and HOV users, hence, all users are tolled. However, this would not be the case in the real world, because Electronic Toll Collection (ETC) technologies that are currently available are capable of differentiating between SOV and HOV users, and thus can toll SOV only.
2. **4 Lane Value Pricing Concept – Toll on SR 520 and I-90:** AM, PM and Off Peak period value pricing on SR 520 from SR 202 to I-5 and I-90 from SR 900 (Issaquah) to I-5. All users (SOV and HOV 3+) on SR 520 will be tolled. Only SOV and HOV 2 will be tolled on I-90, while HOV 3+ will not be subject to toll. Transit will not be tolled on both SR 520 and I-90.

#### **Added HOV Lane Alternative - 6 Lanes**

3. **6-Lane Value Pricing Concept – Toll on SR 520:** AM, PM and Off Peak period value pricing on SR 520 from SR 202 to I-5. All SOV and HOV 2 users will be tolled, while HOV 3+ and transit users will not be tolled.
4. **6-Lane Value Pricing Concept – Toll on SR 520 and I-90:** AM, PM and Off Peak period value pricing on SR 520 from SR 202 to I-5 and I-90 from SR 900 (Issaquah) to I-5. All SOV and HOV 2 users will be tolled, while HOV 3+ and transit users will not be tolled.

#### **Added HOV and GP Lanes Alternative - 8 Lanes**

5. **8-Lane Value Pricing Concept – Toll on SR 520:** AM, PM and Off Peak period value pricing on SR 520 from SR 202 to I-5. All SOV and HOV 2 users will be tolled, while HOV 3+ and transit users will not be tolled.
6. **8-Lane Value Pricing Concept – Toll on SR 520 and I-90:** AM, PM and Off Peak period value pricing on SR 520 from SR 202 to I-5 and I-90 from SR 900 (Issaquah) to I-5. All SOV and HOV 2 users will be tolled, while HOV 3+ and transit users will not be tolled.

#### **Managed Lane Alternative**

The following provides a description of the managed lane alternative that was modeled using PSRC's suite of travel demand models:



## Added HOV and GP Lanes Alternative – 8 Lanes

7. **8-Lane Managed Lanes Concept – 4 General Purpose (GP) Lanes + 4 Managed Lanes:** No pricing on the 4 GP lanes for SOV and HOV 2 users. HOV 3+ and transit users will not be tolled on the 4 managed lanes. HOV 2 users can “buy in” by paying a toll to use the HOV managed lanes. HOV 2 access to the HOV managed lanes will only be allowed at the following locations:

- Montlake Blvd.
- Bellevue Way/104<sup>th</sup> Avenue NE
- I-405 (via HOV direct access ramps)
- Vicinity of NE 32<sup>nd</sup> Street (direct HOV access ramps near Overlake)
- SR 202 (East Terminus)

The decision for providing limited access points for HOV 2 to “buy into” the corridor was dictated by the primary objective of maintaining uncongested travel conditions on the managed lanes, where transit speeds and reliability would not be compromised. Depending on the performance of the limited access points, and the amount of un-used capacity on the managed lanes, additional access points could then be identified along the corridor for HOV 2. If the managed lanes had un-used capacity still available, then SOV trips would be allowed to “buy into” the corridor. In such a case, the tolls for SOV to “buy into” the corridor would be set much higher than that for HOV 2 users.

## METHODOLOGIES FOR MODELING TRANS-LAKE ALTERNATIVES

### Travel Forecasting Analysis

The Puget Sound Regional Council (PSRC) four-county travel demand forecasting model was applied to forecast general traffic, carpool, and transit demand for transportation alternatives studied in the Trans-Lake corridor. The PSRC model is multimodal and captures both regional and corridor-level trip making. The current version of the PSRC model was updated/refined for use on the Trans-Lake Washington Study and Alaskan Way Viaduct (AWV) Project. The aim of the additional validation analysis to the current PSRC model was to achieve an acceptable level of accuracy at key screenline locations critical to the Trans-Lake and AWV projects. The objective of this effort was not to replace or supersede the already validated PSRC model, but to enhance its capabilities to produce more accurate forecasts in the areas under study. It is expected that the methodological components of this model (e.g., trip distribution, mode choice, and time-of-day analysis) will be replaced once the ongoing PSRC model improvement program is successfully completed. The additional PSRC model validation analysis performed by Parsons Brinckerhoff, Inc. for the Trans-Lake and AWV Projects has been documented in the *Travel Forecasting Model Validation Report for Base Year (1998), issued in February 2002*.

Once additional validation analysis was completed for the year 1998, the model was applied to produce future year 2030 baseline travel forecasts as well as forecasts for 6-Lane and 8-Lane Alternatives reflecting additional capacity on SR 520. The baseline forecast is referred to as the “No Action” Alternative and all other Alternatives are compared against it. The “No Action” Alternative includes only those transportation improvements that have committed funding. The main differences among the Alternatives were captured by changes in the highway and transit networks. The future highway and



transit networks, representing each of the Alternatives, were developed using the same coding conventions as used in the 1998 network. Year 2030 travel forecasts were prepared using forecasted population and employment, parking costs, and other data from the PSRC, consistent with the 2030 Metropolitan Transportation Plan adopted in May 2001.

## **Travel Forecasting Analysis Managed Lanes Alternative**

The updated PSRC model was used to produce travel forecasts for a managed lanes alternative on SR 520. The concept modeled included two managed lanes in addition to two lanes for general-purpose traffic in each direction. Access to the managed lanes was restricted to 2+HOVs during both peak and off-peak periods and at the planned direct access locations.

## **Value Pricing Sensitivity Analysis**

As stated previously, the Puget Sound Regional Council's regional travel demand model and forecasting procedures were adapted for analyzing value pricing within the context of tolling limited access facilities. While these tools represent the best methods available for feasibility purposes, this work is at the edge of their intended application, and moreover, the timing is such that this work does not benefit from work-in-progress improvements to the regional model.

The value pricing methodology, developed for PSRC as part of the overall congestion pricing analysis performed during the 2030 MTP development process,<sup>1</sup> was used to perform the pricing sensitivity test for the Trans-Lake Alternatives. In theory, the mechanism by which tolls are simulated within the regional model is relatively simple. On an un-priced roadway, users consider only their own travel time costs, and not the delay costs their vehicle imposes on other users. This behavior tends to result in roadway over-consumption and congestion, especially during peak demand times. Optimal travel behavior – that which theoretically minimizes overall network travel time – could be induced by applying tolls that are equivalent to the incremental delay imposed on others, with the revenues used to make cost-beneficial transportation investments. This is referred to as the “economically efficient” toll.

The modeling approach employed seeks to internalize the external time cost or incremental delay that an additional vehicle imposes on all other vehicles in the traffic stream. When users are compelled to consider this additional cost, some users alter their travel behavior, resulting in lower highway volumes, and higher resulting speeds. As roadway demand increases, the economically efficient or optimal toll also rises at an increasing rate to maintain reasonable speed and flow conditions, by inducing a sufficient number of would-be road users to seek alternative routes, modes, or times to travel.

Model results from this methodology provided an estimate of potential traffic diversion and mode choice effects of pricing on SR 520 and/or I-90 under each Trans-Lake Alternative. This procedure also provides an estimate of pricing time costs that can be used to calculate an average toll rate for each time period on each Trans-Lake facility based on assuming a pertinent value for “willingness-to-pay” or travel time.

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<sup>1</sup> Detailed descriptions are presented in the “Puget Sound Regional Council Transportation Pricing Alternatives Study – Technical Memorandum 3: Simulating Congestion Pricing in EMM/2,” prepared by R. Pozdena, EcoNorthwest, February 19, 2000.



## Estimation of Toll Rates

Estimated optimal toll rates are available from an analysis of value pricing on a system of limited access facilities in King County and southern Snohomish County undertaken for WSDOT Urban Corridor Office. The analysis, which was done in parallel with the evaluation of pricing and managed lanes for the Trans-Lake Washington Project, is described in *Regional Toll Revenue Feasibility Study, Draft Report*, July 2002. The regional modeling assumed the 6-lane alternative for SR 520, no improvements to I-90, and tolls applied to both facilities, as well as other major urban highways including I-5, I-405, SR 167, SR 509 and SR 99.

Optimal toll rates, expressed in time costs as minutes per mile, are derived from the model results – based upon the volumes and volume-to-capacity ratios for each roadway link in the model. Toll rates are aggregated to analysis segments and calculated by time period (AM peak, PM peak, and midday/evening off-peak) and direction of travel over a 15 hour portion of the day. The resulting toll time costs are then converted to monetary units by applying the average willingness to pay for delay reduction, expressed in dollars per hour. Research has shown that this value of time is approximately one-half of the average wage rate. For purposes of these analyses, the value of time was varied between one-third and one-half of the average wage rate for King County to create a range of monetary toll rates. The toll rates are expressed in inflated dollars escalated to the year of collection, and apply to single and two occupant vehicles. Three-plus occupant vehicles and transit vehicles are assumed to use HOV lanes at no charge or would otherwise be exempted from tolls. Trucks are tolled at a multiplier of the auto toll rates.

Tolls are assumed to be collected electronically throughout the regional toll network. The AM and PM peak periods would vary in timing and duration by facility and location, but in no cases are they less than three hours. Peak toll rates would vary noticeably by facility conditions, levels of congestion, and location to remain at their optimal levels. With reduced facility demand, the off-peak toll rates are generally lower. Off-peak tolls would apply to a midday window of time on weekdays, weekday evenings from 7 – 9 PM, and weekends from 6 AM – 9 PM. The network was assumed to be toll-free every day from 9 PM – 6 AM, both to give users an un-priced choice of travel, and also because, in most cases, traffic volumes are not high enough to generate optimal toll rates much above zero.

Application of the toll modeling methodology within the PSRC regional model results in modified traffic forecasts of vehicular travel within the general purpose lanes, and allows for the calculation of the optimal toll rates per mile by time period and analysis segment. Transit vehicles and 3+ HOVs using the toll-free HOV lanes are excluded from these traffic forecasts.

Results for value pricing these facilities individually would likely vary, but the differences may be small in the case of the cross-Lake Washington facilities. The toll modeling reported in this report resulted in volumes and congestion levels for a priced 6-lane Trans-Lake alternative (together with pricing on I-90) similar to those projected for the SR-520 and I-90 components in the *Regional Toll Revenue Feasibility Study's* toll network modeling effort. This is primarily due to the fact that cross-Lake Washington travel is a somewhat captured market with few other reasonable alternatives.

Table 1 presents the 2014 and 2030 range of optimal toll rates per mile by time period and facility for a base value of time equal to one-half the average wage rate for King County, while Table 1a presents a range of optimal toll rates per mile for a low value of time equal to one-third the average wage rate for King County. Year 2014 is assumed as the year of project completion, and 2030 as the planning horizon year. The toll rates are expressed in year 2000 dollars and apply to single and two occupant vehicles. Transit and three-plus occupant vehicles are assumed to use toll-free HOV lanes, when available. Trucks are tolled at a multiplier of the auto toll rates.



**Table 1: Weekday Toll Rate Estimates / Base Value of Time Equals 1/2 Wage Rate****Model Estimated Toll Rates (Year 2000 \$) – 2014**

<i>Toll Facility</i>	<i>Toll Distance</i>	<i>PM Peak Period — \$ / mi</i>			<i>AM Peak Period — \$ / mi</i>		
		<i>Minimum</i>	<i>Maximum</i>	<i>Average</i>	<i>Minimum</i>	<i>Maximum</i>	<i>Average</i>
I-90	13.3	\$0.03	\$0.19	\$0.09	\$0.03	\$0.13	\$0.06
SR 520	12.8	\$0.04	\$0.31	\$0.14	\$0.03	\$0.21	\$0.09

Note: All amounts are in year 2000 dollars and are based on a value of time of \$11.83 / hour

SR 520 tolled sections include the entire facility

I-90 tolled sections extend from I-5 to SR 900 in Issaquah

Off peak toll rates range from 3¢ to 5¢ per mile

**Model Estimated Toll Rates (Year 2000 \$) – 2030**

<i>Toll Facility</i>	<i>Toll Distance</i>	<i>PM Peak Period — \$ / mi</i>			<i>AM Peak Period — \$ / mi</i>		
		<i>Minimum</i>	<i>Maximum</i>	<i>Average</i>	<i>Minimum</i>	<i>Maximum</i>	<i>Average</i>
I-90	13.3	\$0.03	\$0.22	\$0.13	\$0.03	\$0.13	\$0.07
SR 520	12.8	\$0.06	\$0.40	\$0.19	\$0.03	\$0.21	\$0.11

Note: All amounts are in year 2000 dollars and are based on a value of time of \$11.83 / hour

SR 520 tolled sections include the entire facility

I-90 tolled sections extend from I-5 to SR 900 in Issaquah

Off peak toll rates range from 3¢ to 7¢ per mile

**Table 1a: Weekday Toll Rate Estimates / Low Value of Time Equals 1/3 Wage Rate****Model Estimated Toll Rates (Year 2000 \$) – 2014**

<i>Toll Facility</i>	<i>Toll Distance</i>	<i>PM Peak Period — \$ / mi</i>			<i>AM Peak Period — \$ / mi</i>		
		<i>Minimum</i>	<i>Maximum</i>	<i>Average</i>	<i>Minimum</i>	<i>Maximum</i>	<i>Average</i>
I-90	13.3	\$0.02	\$0.12	\$0.06	\$0.02	\$0.09	\$0.04
SR 520	12.8	\$0.03	\$0.20	\$0.09	\$0.02	\$0.14	\$0.06

Note: All amounts are in year 2000 dollars and are based on a value of time of \$7.89 / hour

SR 520 tolled sections include the entire facility

I-90 tolled sections extend from I-5 to SR 900 in Issaquah

Off peak toll rates range from 2¢ to 3¢ per mile

**Model Estimated Toll Rates (Year 2000 \$) – 2030**

<i>Toll Facility</i>	<i>Toll Distance</i>	<i>PM Peak Period — \$ / mi</i>			<i>AM Peak Period — \$ / mi</i>		
		<i>Minimum</i>	<i>Maximum</i>	<i>Average</i>	<i>Minimum</i>	<i>Maximum</i>	<i>Average</i>
I-90	13.3	\$0.02	\$0.15	\$0.09	\$0.02	\$0.08	\$0.05
SR 520	12.8	\$0.04	\$0.27	\$0.12	\$0.02	\$0.14	\$0.07

Note: All amounts are in year 2000 dollars and are based on a value of time of \$7.89 / hour

SR 520 tolled sections include the entire facility

I-90 tolled sections extend from I-5 to SR 900 in Issaquah

Off peak toll rates range from 2¢ to 5¢ per mile



The following points should be noted in interpreting these toll rates in the context of the Trans-Lake transportation pricing alternatives analysis.

- If value pricing was implemented only on SR 520, then the travel cost of the I-90 alternative route could look relatively more favorable than if both crossings were value priced. This could lead to more diversion to I-90, and an equilibrium situation that results in lower volumes, and thus, lower V/C ratios and toll rates on SR 520 than shown in Table 1 and 1a.
- Because the toll rates in Table 1 and 1a are from a system-wide analysis of value pricing, in the absence of tolls on the other facilities, diversion from SR 520 and I-90 to drive-around options could be greater, and thus, actual maximum toll rates could be lower than those presented.
- ***Estimate of Average Toll on SR 520 – Base Value of Time Equals One-Half the Wage Rate.***  
Assuming a maximum trip length of 12.8 miles on SR 520, the **average** toll for a one-way peak period trip across SR 520 from Redmond (SR 202) to Seattle (I-5) in 2014 (assumed year for implementing tolls) and 2030 is shown in Table 2. Average tolls for a one-way peak period trip from I-405 to I-5 (6.8 miles) is also provided. These values of toll are reported in year 2000 constant dollars.
- ***Estimate of Average Toll on I-90 – Base Value of Time Equals One-Half the Wage Rate.***  
Assuming a maximum trip length of 13.3 miles on I-90, the **average** toll for a one-way peak period trip across I-90 from Issaquah (SR 900) to Seattle (I-5) in 2014 and 2030 is also shown in Table 2. Average tolls for a one-way peak period trip from I-405 to I-5 (7.3 miles) is also provided. These values of toll are also reported in year 2000 constant dollars.

**Table 2: Average Toll for a One-way Trip (2000 Constant Dollars)**  
**Base Value of Time (Equals 1/2 Wage Rate)**

Facility	Trip Length	Average Toll in 2014	Average Toll in 2030
SR 520	12.8 miles (SR 202 to I-5)	\$1.15 - \$1.80	\$1.41 - \$2.43
	6.8 miles (I-405 to I-5)	\$0.61 - \$0.95	\$0.75 - \$1.30
I-90	13.3 miles (SR 202 to I-5)	\$0.80 - \$1.20	\$0.93 - \$1.73
	7.3 miles (I-405 to I-5)	\$0.44 - \$0.66	\$0.51 - \$0.95

- ***Estimate of Average Toll on SR 520 – Low Value of Time Equals One-Third the Wage Rate.***  
Assuming a maximum trip length of 12.8 miles on SR 520, the **average** toll for a one-way peak period trip across SR 520 from Redmond (SR 202) to Seattle (I-5) in 2014 (assumed year for implementing tolls) and 2030 is shown in Table 2a. Average tolls for a one-way peak period trip from I-405 to I-5 (6.8 miles) is also provided. These values of toll are reported in year 2000 constant dollars.
- ***Estimate of Average Toll on I-90 – Low Value of Time Equals One-Third the Wage Rate.***  
Assuming a maximum trip length of 13.3 miles on I-90, the **average** toll for a one-way peak



period trip across I-90 from Issaquah (SR 900) to Seattle (I-5) in 2014 and 2030 is also shown in Table 2a. Average tolls for a one-way peak period trip from I-405 to I-5 (7.3 miles) is also provided. These values of toll are also reported in year 2000 constant dollars.

**Table 2a: Average Toll for a One-way Trip (2000 Constant Dollars)**  
**Low Value of Time (Equals 1/3 Wage Rate)**

Facility	Trip Length	Average Toll in 2014	Average Toll in 2030
SR 520	12.8 miles (SR 202 to I-5)	\$0.77 - \$1.15	\$0.90 - \$1.54
	6.8 miles (I-405 to I-5)	\$0.41 - \$0.61	\$0.48 - \$0.82
I-90	13.3 miles (SR 202 to I-5)	\$0.53 - \$0.80	\$0.67 - \$1.20
	7.3 miles (I-405 to I-5)	\$0.29 - \$0.44	\$0.37 - \$0.66

### Estimation of Toll Revenue

Revenue estimates for the tolling of a six-lane SR-520 over its entire 12.8 mile length without tolling I-90 have been developed as part of the Trans-Lake Washington Project and are presented herein. The procedures used for arriving at revenue estimates borrow from the economically efficient toll methods developed and applied in the *Regional Toll Revenue Feasibility Study* and the *Alaskan Way Viaduct Toll Feasibility Study*, but do not fully replicate all of these steps for various reasons.<sup>2</sup> In particular, the existing Trans-Lake toll modeling had not considered the simulation of the proposed highway improvements in the base year of 1999. This set of results would typically be necessary to provide an additional point in time to be compared with the future year in order to interpolate volumes and calculate toll rates revenues, and diversion results for intermediate years. In light of this and other constraints, a streamlined approach was developed that relies on some of the SR-520 toll assumptions and results of the *Regional Toll Revenue Feasibility Study* in order to generate revenue estimates for a stand-alone six-lane SR-520 toll facility.

The economically efficient toll methods essentially derive toll rates that approximate the external costs that an individual roadway user imposes on all other users by choosing to travel at a particular time and location. The toll rates are a function of the volume and capacity conditions that would exist after iteratively applying a modified volume-delay function in the modeling process to account for these external delay costs. The reader is referred to the *Regional Toll Revenue Feasibility Study* for a more detailed explanation of the optimal toll theory and application methods.

The streamlined approach undertaken dictates that toll revenue can only be reasonably estimated for the Trans-Lake alternative that matches the one modeled in the regional tolling study — the six-lane SR-520 configuration. Modeling results for 2030 with and without tolls on SR-520 only were used to estimate

<sup>2</sup> The *Alaskan Way Viaduct Toll Feasibility Study* is dated June 2002 and the *Regional Toll Revenue Feasibility Study (Working Draft)* is dated July 18, 2002. Both were prepared by Parsons Brinckerhoff for the WSDOT Office of Urban Corridors.





gross diversion rates and volume-to-capacity ratios, the latter which serve as inputs to deriving optimal toll rates by time period and direction. Upward adjustments were made to some of the resulting volume-to-capacity ratios for the following reasons. First, the Trans-Lake “without toll” model runs resulted in slightly lower volumes than did the regional toll study “without toll” model runs, particularly during the AM peak period, despite an expectation that they would be about the same. Second, the toll modeling methods used, when applied to a limited one-facility toll network, tend to be more likely to overstate gross diversion in the “with toll” case, and thus, understate revenue, than when tolling is more widespread. Finally, additional model runs to further refine the Trans-Lake toll modeling results to better match the procedures applied in modeling the regional toll network were not possible at this time.

Assumptions regarding the range for the value of time, the time-of-day distribution of traffic, percentage of traffic within the 15-hour toll period, the percentage of trucks by time period, and weekday to weekend factors, among others, were borrowed from the *Regional Toll Revenue Feasibility Study*. Using these assumptions and the calculation tools developed for the regional tolling analysis, a range of revenue was estimated for the stand-alone six-lane SR-520 toll facility.

The range of revenue varies from:

- a “low end” estimate that excludes weekend tolling, uses a relatively low 2x toll multiplier for trucks, and applies a conservative low value of time at one-third the average wage rate;
- to a more likely “high end” value that includes weekends at the off-peak toll rates, a 3x toll multiplier for trucks, and a base value of time at one-half the average wage rate.

This range of revenue was then compared to SR-520's share of 2030 revenue from the regional tolling analysis, and the resulting relationships were used in combination with the 2014 regional tolling revenue estimate for SR-520 to also obtain a 2014 revenue estimate for the stand-alone toll facility.<sup>3</sup>

Findings and results from the revenue analysis of value pricing travel on SR 520 are as follows.

- The 2030 revenue estimate for a stand-alone SR-520 represents 77% of the revenue generated by SR-520 under the regional toll network.
- From a traffic standpoint, the stand-alone toll facility carries 93% of the tolled vehicle miles that are accommodated by SR-520 in the regional toll network (measured over the 15-hour weekday toll period and weekends where applicable).
- Both of these results are expected — in the absence of tolling on I-90 (and I-5/I-405 for that matter), there is more of an incentive for some SR-520 users to divert to I-90 to avoid the toll. Because the optimal toll rate rises exponentially with traffic volumes, 7% lower traffic volumes actually result in 23% lower toll revenues.
- The average toll period gross diversion for SR-520 as a stand-alone toll facility is 23.1%, compared to 18.5% when part of a regional toll network. Gross diversion rates include those travelers who shift modes to transit or HOVs (carpools) and continue to use the facility at the same time.

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<sup>3</sup> The base value of time is \$11.89 per hour and the low value of time is \$7.89 per hour, in 2000 dollars.



Applying the 77% revenue factor to the 2014 regional toll revenue estimates for SR-520 yields an estimated range of toll revenue for SR-520 as a single toll facility. This range approximates the revenue estimates that would likely have resulted with the full application of the toll feasibility methods to a stand-alone six-lane SR-520 toll facility. The revenue range for a stand-alone six-lane SR-520 toll facility is reported in Table 3 for both 2014 and 2030 in inflated, year of collection dollars.

**Table 3: Range of Toll Revenue Estimates for a Six-Lane SR-520 Facility**

<b>Year</b>	<b>SR-520 Toll Distance (miles)</b>	<b>SR-520 Annual Revenue Range (Inflated Dollars)</b>	
		<b><u>LOW END:</u> Low Value of Time Weekends Toll-Free 2x Truck Toll Factor</b>	<b><u>HIGH END:</u> Base Value of Time Weekend Tolling 3x Truck Toll Factor</b>
2014	12.8	\$17.7 M	\$30.9 M
2030	12.8	\$38.4 M	\$66.7 M

## PERFORMANCE AND EVALUATION OF TRANSPORTATION PRICING AND MANAGED LANE CONCEPTS

This section summarizes the transportation performance of the six transportation pricing and one managed lanes concept for the SR 520 corridor. Five mobility criteria were developed for use in the evaluation of these concepts. They are as follows:

- vehicle throughput
- person throughput
- traffic diversion
- volume to capacity (V/C) ratios and speeds
- mode shares

These criteria provide measures of the relative contributions of pricing and managed lanes on the SOV, HOV, and transit trips on the Trans-Lake corridor. It should also be noted that the information presented in this section is an evaluation of the relative performance of the alternatives under each mobility criteria and should not be considered as a representation of the absolute performance of any single pricing alternative.

The Puget Sound Regional Council's travel demand forecasting model was the primary information source for modeling the impacts of pricing and managed lanes on the SR 520 corridor. The PSRC model forecasts daily and peak period travel demand for the corridor in the year 2030. The model forecasts person trips and vehicle trips, and also provides information on travel speeds, volume to capacity ratios,



and mode of travel. The model also provides information on any diversion of traffic caused by the introduction of tolls for crossing Lake Washington. The relative performance of the pricing and managed lanes concepts under each mobility criteria is discussed below.

## **Evaluation of Value Pricing Concepts**

The evaluation of the transportation pricing alternatives focuses on 2030 travel conditions under two sets of pricing assumptions:

1. Peak period tolls on SR 520 Only – for the full length of the corridor (see Table 2 and Table 2a for average toll rates)
2. Peak period tolls on SR 520 and I-90 – for the full length of the corridor (see Table 2 and Table 2a for average toll rates)

The extent of the analysis is limited to an evaluation of cross-Lake Washington traffic patterns across a screenline that represents the following three facilities:

- SR 520 (Lake Washington Bridge)
- I-90 (West Bridge)
- SR 522 (West of 61<sup>st</sup> Avenue NE)

Presented below is a detailed evaluation of cross-Lake Washington traffic patterns for the 4, 6, and 8 Lane alternatives under the two pricing concepts. This includes an analysis of person throughput, vehicle throughput, traffic diversion, V/C ratios and speeds, and mode shares for each of the Trans-Lake alternatives.

### **Person Throughput**

The total travel demand of daily person trips on the three facilities for the two pricing concepts is illustrated in Figures 1, 2, and 3. These figures summarize the total daily person trip activity and compares daily travel demand on SR 520, I-90, and SR 522 across the three different alternatives (4 Lane, 6 Lane and 8 Lane) under the “No Toll” and Toll scenarios. The Appendix to this report provides detailed forecasts of person trips by mode of travel for the different alternatives under the “No Toll” and Toll scenarios.

#### ***Observations – Toll on SR 520 Only***

Irrespective of the number of lanes on SR 520, the application of toll on SR 520 results in a general reduction of 10% to 15% of the daily person trips using SR 520. On the other hand, both I-90 and SR 522 show increases in daily person trip activity. I-90 increases are between 5% to 9%, while SR 522 show increases of 3% to 5%.

#### ***Observations – Toll on SR 520 and I-90***

The application of value pricing on both SR 520 and I-90 shows reductions in daily person trip activity across both SR 520 and I-90, while SR 522 shows increases. Both SR 520 and I-90 show decreases of 6% to 12%, while SR 522 shows corresponding increases of 5% to 15% in daily person trip activity.

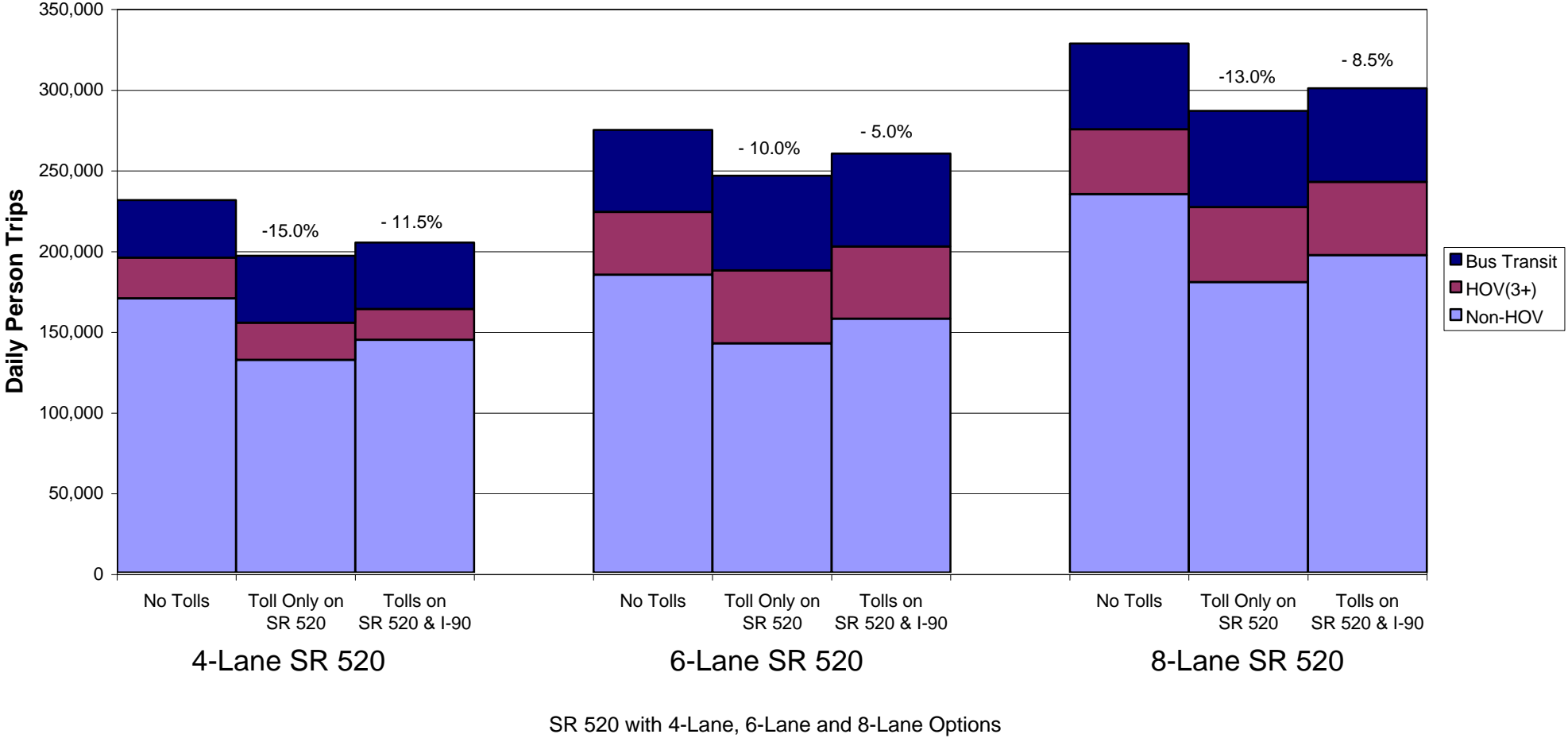


## ***Summary***

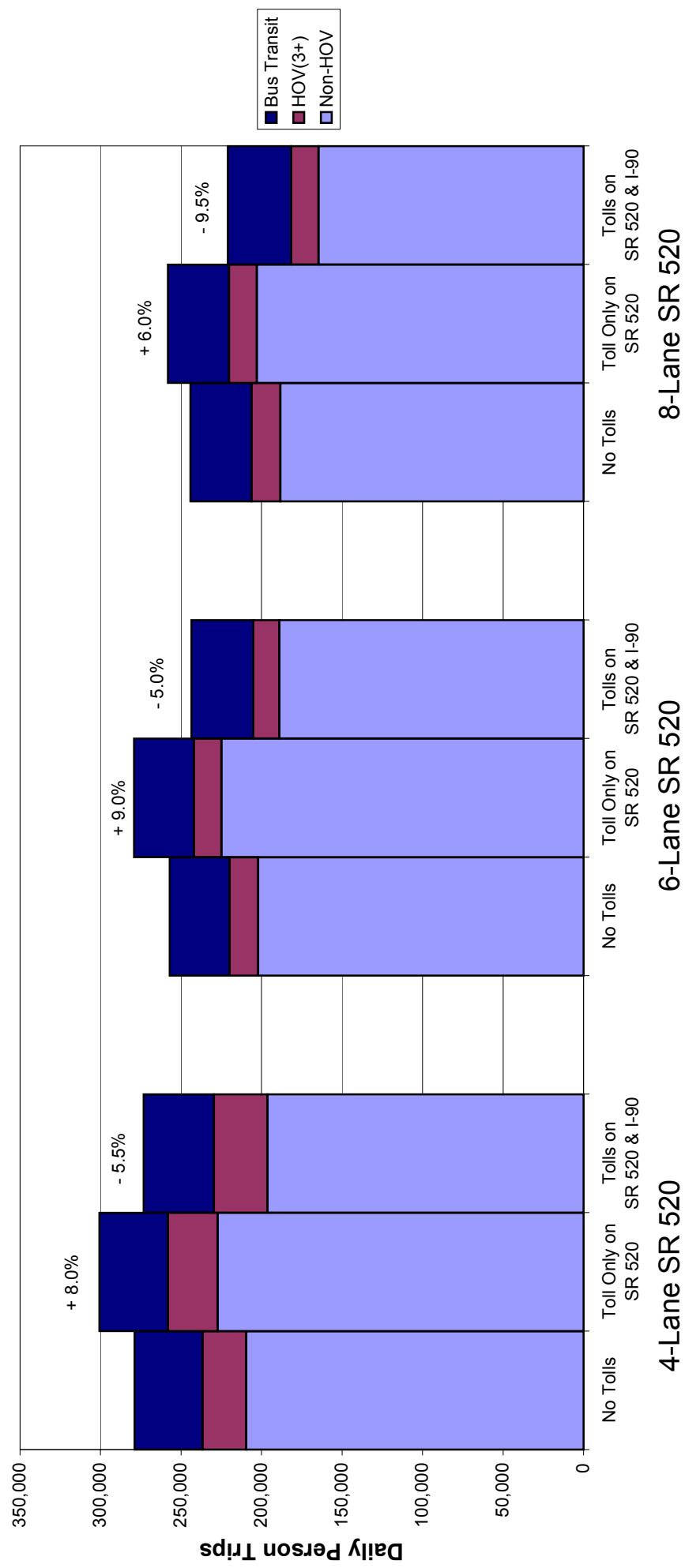
The introduction of value pricing on Lake Washington crossings leads to an overall 6% - 15% reduction in daily person trips crossing Lake Washington. On the other hand, SR 522 shows increases in daily person trip activity ranging between 5% and 15%. To conclude, the introduction of tolls to SR 520 and/or I-90 results in a reduction of total person throughput across Lake Washington.



**Figure 1**  
**Daily Person Trip Comparison on SR-520**

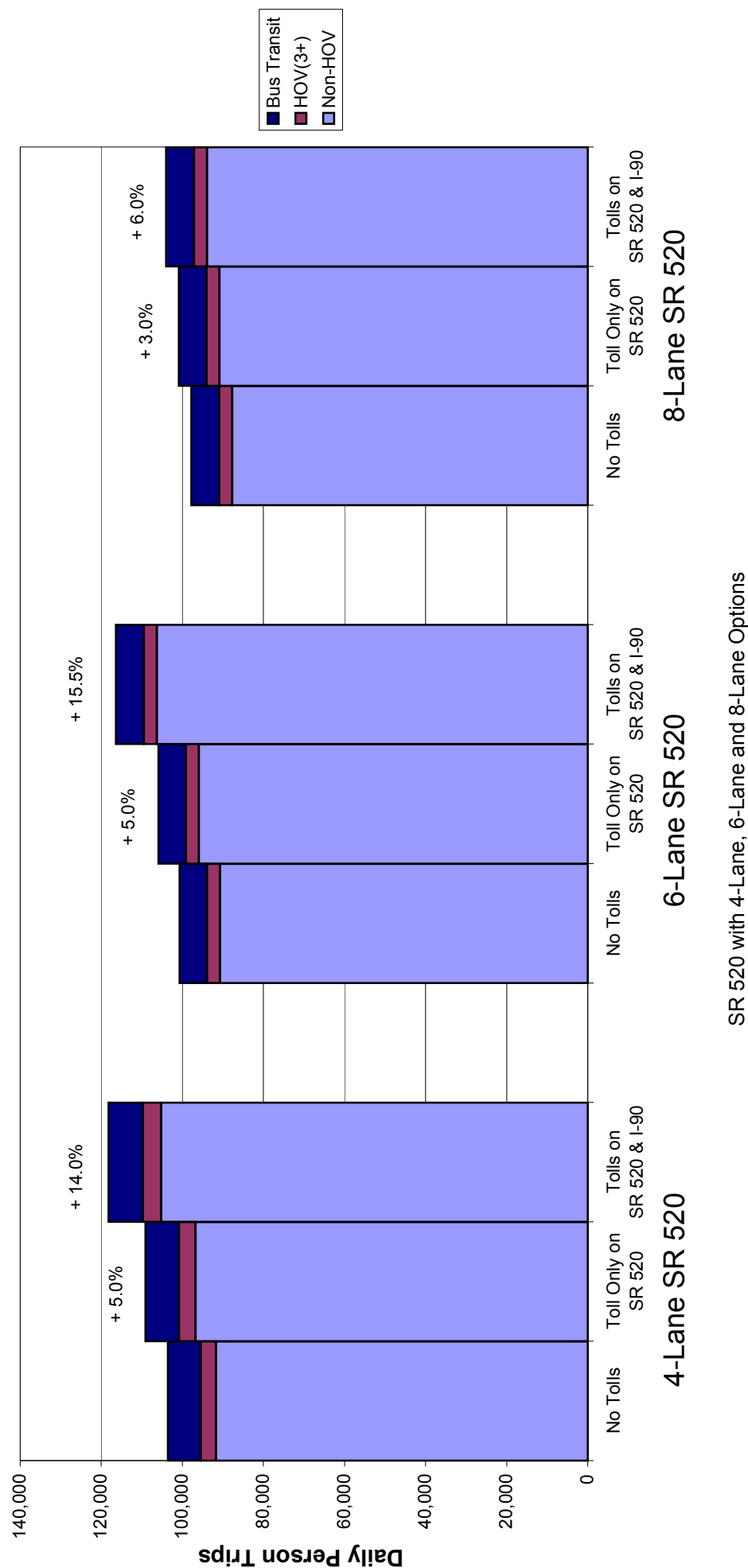


**Figure 2**  
**Daily Person Trip Comparison on I-90**



SR 520 with 4-Lane, 6-Lane and 8-Lane Options

**Figure 3**  
**Daily Person Trip Comparison on SR-522**



## Vehicle Throughput

The total demand for vehicular trips on the three facilities for the two pricing concepts is illustrated in Figures 4, 5, and 6. These figures summarize the total daily HOV and non-HOV (SOV) vehicle trip activity and compares daily vehicular travel demand on SR 520, I-90, and SR 522 across the three different alternatives (4 Lane, 6 Lane and 8 Lane) under the “No Toll” and Toll scenarios. The Appendix to this report provides detailed forecasts by mode of travel for the different alternatives under the “No Toll” and Toll scenarios.

### ***Observations – Toll on SR 520 Only***

*Non-HOV Trips* - irrespective of the number of lanes on SR 520, the application of tolls on SR 520 results in a reduction of about 23% of the daily non-HOV trips using SR 520. On the other hand, I-90 shows increases of between 8% and 11% in non-HOV trip activity, and SR 522 also increases of about 4% to 6%.

*HOV Trips* – tolls on SR 520, result in an increase of almost 17% of HOV trips on SR 520. HOV trips on I-90 decrease by about 4%, while SR 522 shows no change in HOV trip activity.

### ***Observations – Toll on SR 520 and I-90***

*Non-HOV Trips* - the application of tolls on both SR 520 and I-90 show reductions in daily non-HOV trips across both SR 520 and I-90, while SR 522 shows an increase in SOV trip activity. SR 520 shows the most reduction of SOV trips, in the order of 14% to 16%, while, I-90 shows a reduction of between 6% and 12%. On the other hand, SR 522 shows an increase in non-HOV trip activity ranging between 7% and 17%.

*HOV Trips* – tolls on both SR 520 and I-90 result in an increase of between 13% and 15% of HOV trips on SR 520, while I-90 shows a decrease of between 5% and 9% in HOV trip activity. SR 522 shows no change in HOV trip activity.

### ***Summary***

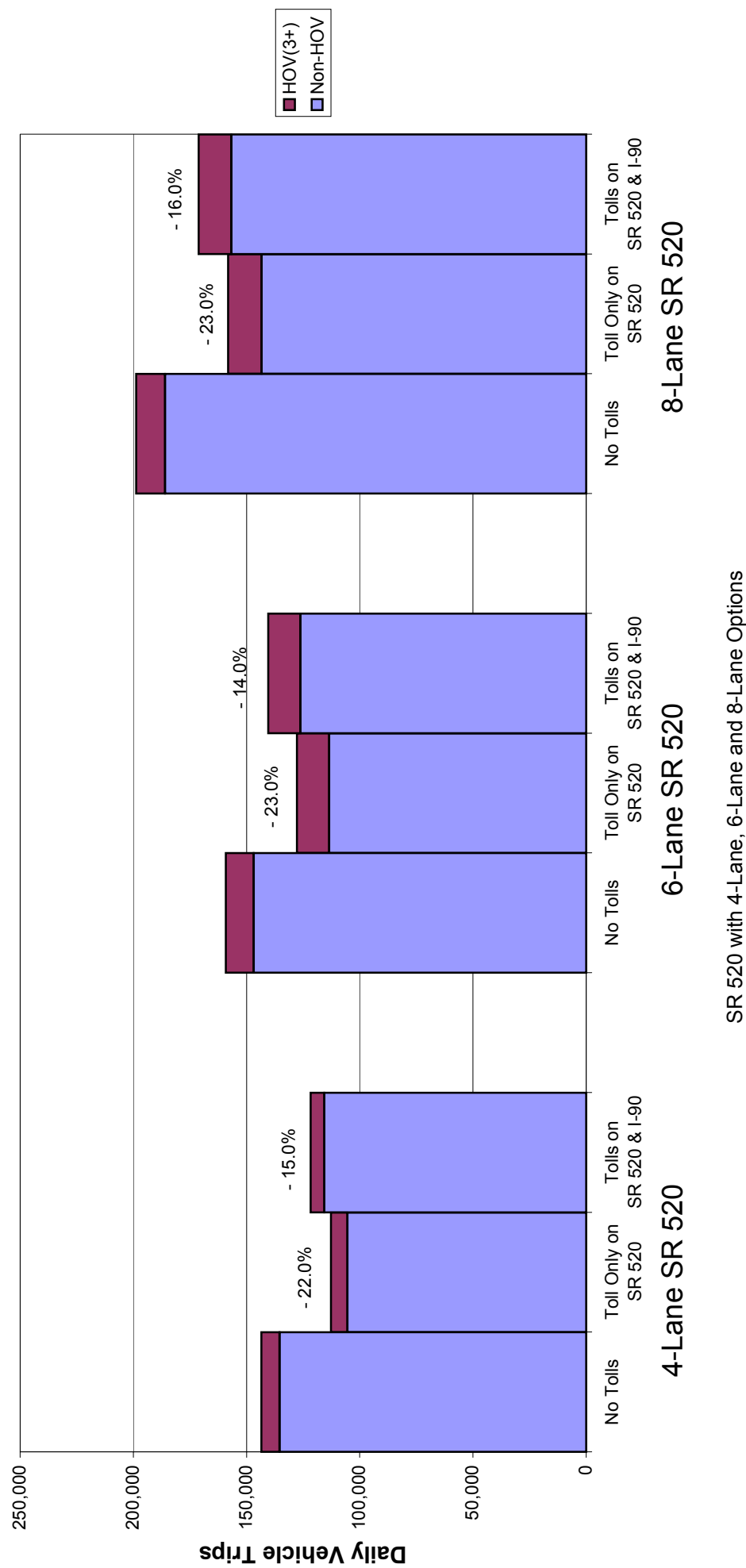
The introduction of value pricing on Lake Washington crossings leads to an overall reduction of between 16% and 23% of non-HOV trips on SR 520 and I-90, while, SR 522 shows increases in non-HOV trips ranging from 4% to 17%. With respect to HOV trips, SR 520 experiences increases ranging between 13% and 17% in HOV trip activity, while, I-90 shows a decrease of about 5% to 9% in HOV trip activity, and SR 522 shows no change.

To conclude, the introduction of tolls result in a reduction of non-HOV trips crossing the Lake on SR 520 and I-90, accompanied by an increase in SOV trips going around the Lake on SR 522. There is also an increase in the total number of HOV trips crossing the Lake on both SR 520 and I-90, with SR 520 being the preferred crossing for the majority of HOV trips.

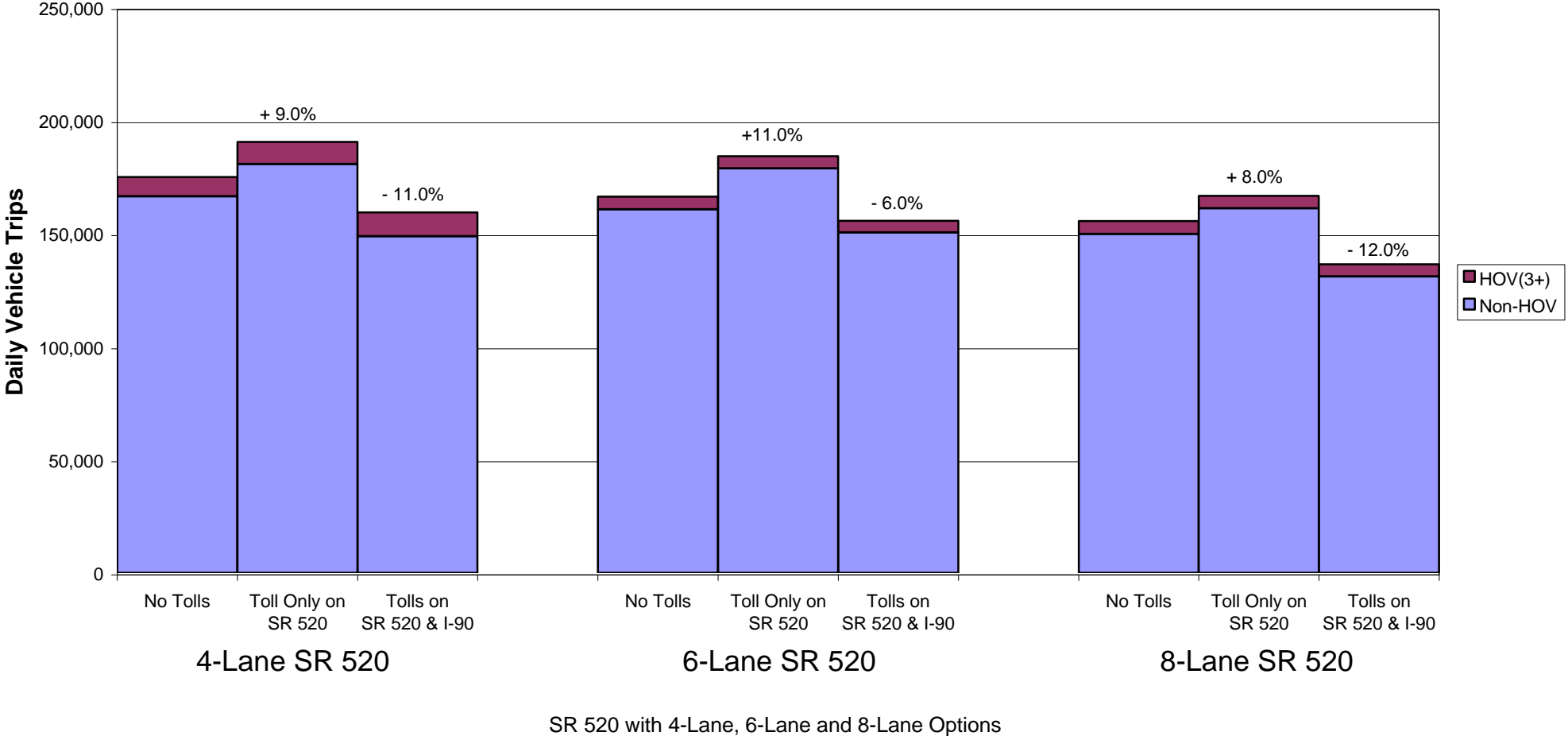




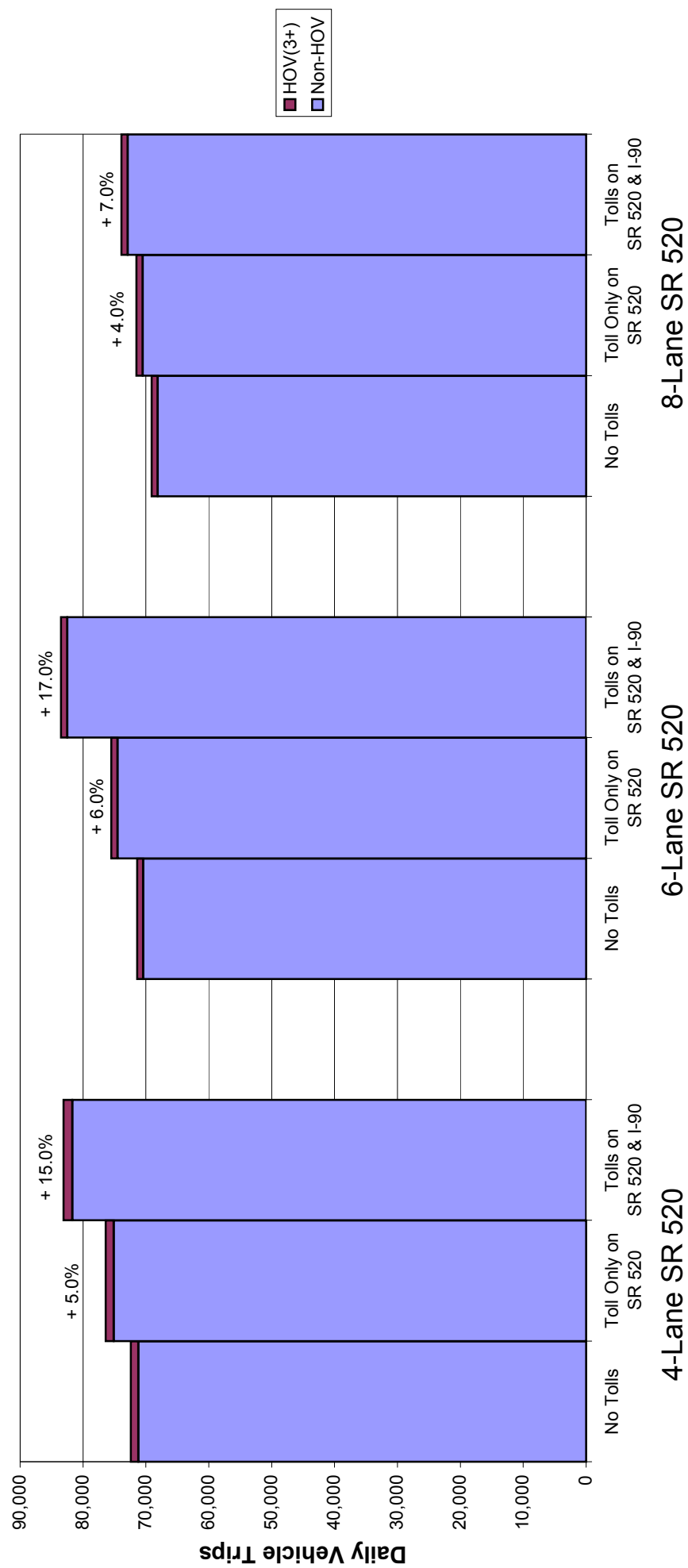
**Figure 4**  
**Daily Vehicle Trip Comparison on SR-520**



**Figure 5**  
**Daily Vehicle Trip Comparison on I-90**



**Figure 6**  
**Daily Vehicle Trip Comparison on SR-522**



SR 520 with 4-Lane, 6-Lane and 8-Lane Options

## **Traffic Diversion**

Changes in the daily travel pattern of vehicular trips are presented in Figures 7 and 8. Figure 7 illustrates the daily travel patterns of vehicular trips resulting from the application of tolls on SR 520, while Figure 8, illustrates the daily travel patterns resulting from the application of tolls on both SR 520 and I-90. It should be noted that these changes in daily travel patterns are based on a comparison of model results from the “No Toll” and “Toll” scenarios respectively.

### ***Observations – Toll on SR 520 Only***

*Daily Travel Patterns* - irrespective of the number of lanes on SR 520, the application of tolls on SR 520, result in a reduction of almost 20% of the daily vehicle trips on SR 520, as shown in Figure 7. In addition to the general reduction of trips on SR 520, the following daily traffic patterns results from value pricing SR 520 only:

- 9% increase in vehicle trips on I-90;
- 6% increase in vehicle trips on SR 522;
- 1% to 2% increase in vehicle trips on I-405 (south of the Trans-Lake corridor); and,
- 3% to 5% increase in vehicle trips on arterial roadways in Seattle, Bellevue, Kirkland, Redmond, and the Points Communities.

### ***Observations – Toll on SR 520 and I-90***

*Daily Travel Patterns* - irrespective of the number of lanes on SR 520, the application of tolls on SR 520 and I-90, result in a reduction of nearly 13% to 14% of the daily vehicle trips on I-90 and SR 520, as shown in Figure 8. In addition, the following daily traffic patterns results from value pricing SR 520 and I-90:

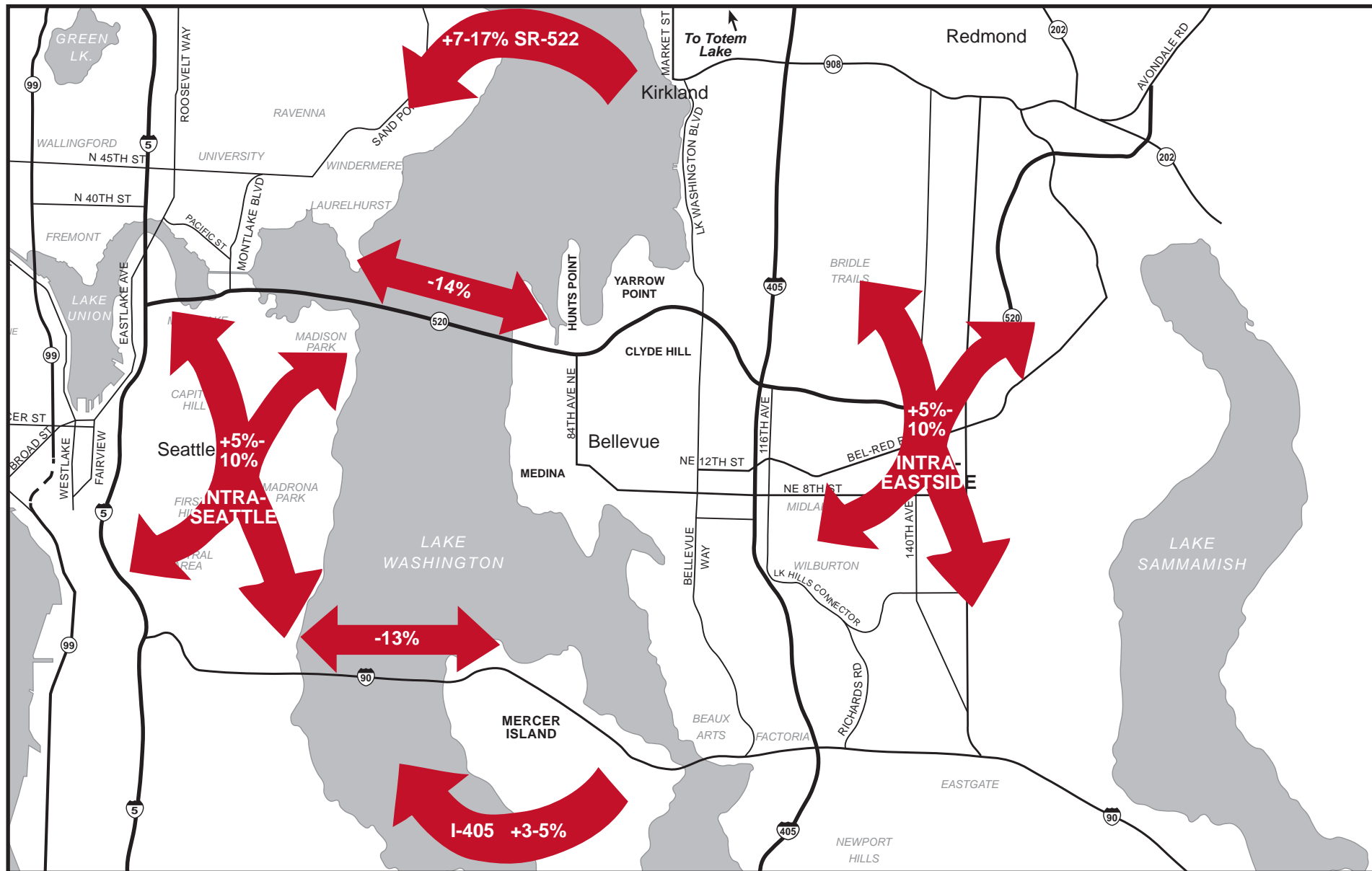
- 7% to 17% increase in vehicle trips on SR 522;
- 3% to 5% increase in vehicle trips on I-405 (south of the Trans-Lake corridor); and
- 5% to 10% increase in vehicle trips on arterial roadways in Seattle, Bellevue, Kirkland, Redmond, and the Points Communities.

### ***Summary***

The introduction of value pricing on SR 520 and I-90 results in an increase of 7% to 17% of the daily vehicle trips on SR 522, accompanied by a 3% to 10% increase in daily vehicle trips on arterial roadways in Seattle, Bellevue, Kirkland, Redmond, and the Points Communities.







**Figure 8**  
Daily Travel Pattern Changes  
Pricing on SR-520 & I-90

## **Volume to Capacity (V/C) Ratios and Speeds**

The following is a discussion on changes in volume to capacity (V/C) ratios and operating speeds on the Lake Washington bridge under the “No Toll” and Toll conditions. Figures 9 thru 17, display changes to V/C ratios and operating speeds for the 4, 6, and 8 Lane alternatives.

### ***Calculation of V/C Ratios and Speeds***

The V/C ratios and speeds for the SR 520 bridge under the 4, 6, and 8 Lane alternatives was calculated based on the following assumptions:

- 2030 daily traffic forecasts for the 4, 6, and 8 Lane alternatives under the “No Toll” and “Toll” conditions served as the starting point for this analysis.
- Existing daily traffic volume distribution on SR 520 (near 76<sup>th</sup> Street) was used to generate the future hourly traffic volume distribution for the general purpose lanes and the HOV lanes.
- The 4 Lane alternative assumes a lane capacity of 2000 vehicles per hour for the general purpose lanes under the 4 Lane alternative.
- The 6 Lane alternative assumes a higher lane capacity of 2100 vehicles per hour. The added capacity reflects improvements to the SR 520 bridge, i.e., shoulder width, standard lane width, and improved sight distance.
- The 8 Lane alternative assumes a lane capacity of 2200 vehicles per hour per lane. In this case a slightly higher capacity per lane was assumed to take into account the two additional lanes that are being considered on the SR 520 bridge, in addition to the standard improvements to shoulder width, lane width, and improved sight distance.
- A HOV lane capacity of 1800 vehicles per hour for the 6 and 8 Lane alternatives.
- Buses were converted to passenger car equivalents (PCE) and added to the general purpose lane volumes under the 4 Lane alternative, and to the HOV lane volumes for the 6 and 8 Lane alternatives.
- A PCE conversion factor of 3.1 was used. This assumes 50 percent of the buses to be articulated with a PCE of 4 and the remainder to be single unit buses with a PCE factor of 2.2.
- 2030 general purpose traffic volumes were converted to PCEs assuming 5% heavy vehicles with a PCE factor of 2.2.

### ***Observations – Toll on SR 520 Only***

Figure 9 presents V/C ratios and operating speeds on the Lake Washington bridge for the 4 Lane alternative under the “No Toll” scenario, while Figure 10 presents the same information under toll conditions. Introduction of tolls on SR 520 shows a 20% reduction in V/C ratios (from 1.40 to 1.10) during the peak periods, resulting in an increase in operating speeds from below 10 mph to about 20 mph. A similar reduction in V/C ratios (from 1.15 to 0.90) is observed during the off-peak period, with operating speeds improving from 10 mph to 60 mph.



Similar trends in V/C ratios and operating speeds are observed with the 6 Lane alternative. Figures 12 and 13 present changes in V/C ratios and speeds from the 6 Lane alternative. Tolls on SR 520 result in a 24% reduction in V/C ratios during the peak periods (from 1.25 to 0.95), with operating speeds on the general purpose lanes increasing from below 10 mph to 55 mph during peak period conditions. During the off-peak period the V/C ratios drop by about 22% (from 1.15 to 0.90) and operating speeds on the general purpose lanes improve from below 20 mph to 60 mph.

The 8 Lane alternative shows trends in V/C ratios similar to the 4 and 6 Lane alternatives, however, the improvement to operating speeds are not as much as that observed with the 4 and 6 Lane alternatives. Figures 15 and 16 present changes in V/C ratios and speeds from the 8 Lane alternative. In this case, tolls on SR 520 result in a 20% reduction in V/C ratios during the peak periods (from 1.00 to 0.80), with operating speeds on the general purpose lanes improving from 45 mph to 60 mph. During the off-peak period the V/C ratios drop by about 22 % (from 0.90 to 0.70), however, there is no change in the operating speeds on the general purpose lanes. This is because the V/C ratios and operating speeds from the 8 Lane alternative under the “No Toll” conditions shows peak period congestion levels much lower than that compared to the 4 and 6 Lane alternatives. In other words, the greater the congestion is during peak periods (high V/C ratios and low speeds) under “No Toll” conditions, the larger the resulting change in V/C ratios and operating speeds from the introduction of tolls.

On the other hand, operating conditions on HOV lanes in the Trans-Lake corridor lanes do not deteriorate when either the 4, 6 or 8 lane alternatives are tolled. V/C ratios on HOV lanes are below 0.80 with operating speeds of 55 mph to 60 mph.

### ***Observations – Toll on SR 520 and I-90***

Changes to V/C ratios and operating speeds on the Lake Washington bridge when both SR 520 and I-90 are tolled is presented in Figures 11, 14, and 17.

As shown in Figures 9 and 11, toll on SR 520 and I-90 under the 4 Lane alternative results in a 15% reduction in V/C ratios during the peak periods (from 1.40 to 1.20), with no change in operating speeds on SR 520. A similar reduction of about 17% in V/C ratios (from 1.15 to 0.95) is observed during the off-peak period, with operating speeds on SR 520 improving from 10 mph to 55 mph.

Figures 12 and 14, show changes in V/C ratios and operating speeds from the 6 Lane alternative. Tolls on SR 520 and I-90 result in a 15% reduction in V/C ratios during the peak periods, with operating speeds on the general purpose lanes improving from below 10 mph to about 20 mph. During the off-peak period the V/C ratios improve by about 18% (from 1.15 to 0.95), and operating speeds on the general purpose lanes improve from 20 mph to 55 mph.

Figures 15 and 17, show changes in V/C ratios and operating speeds from the 8 Lane alternative. Tolls on SR 520 and I-90 result in a 15% reduction in V/C ratios during the peak periods (from 1.0 to 0.85), with operating speeds on the general purpose lanes improving from about 45 mph to 60 mph. During the off-peak period the V/C ratios drop by 17% (from 0.90 to 0.75), however, there is no change in the operating speeds on the general purpose lanes. They continue to operate at free-flow conditions of 60 mph. Once again, because of the low levels of congestion observed during the peak and off-peak period from the 8 Lane alternative with no tolls, the response to tolls from this alternative is not as much as that reflected in the 4 and 6 Lane alternatives.

As with the case of tolling SR 520 only, operating conditions on HOV lanes in the Trans-Lake corridor lanes do not deteriorate when either the 4, 6 or 8 lane alternatives are tolled. V/C ratios on HOV lanes are below 0.80 with operating speeds of 55 mph to 60 mph.



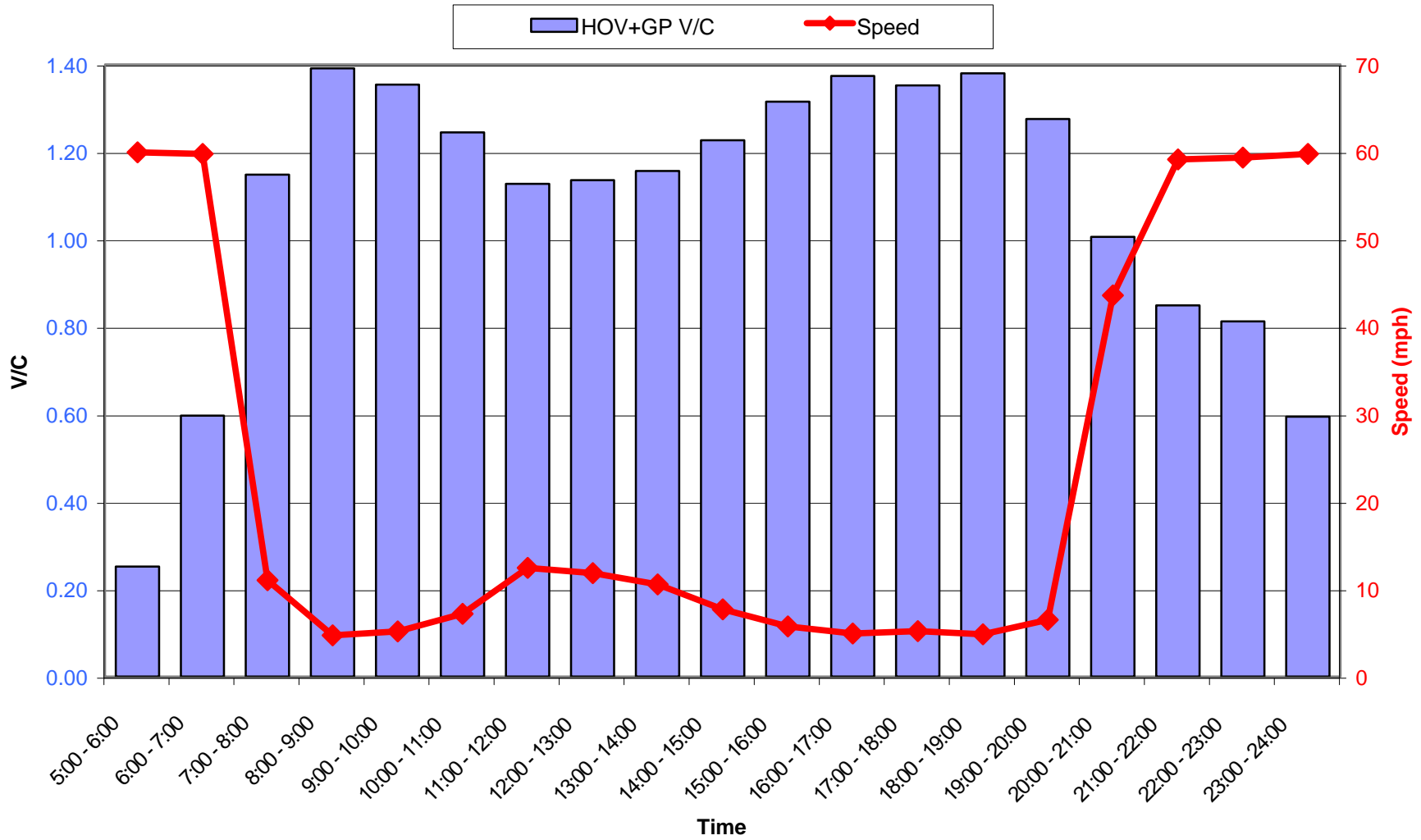


## ***Summary***

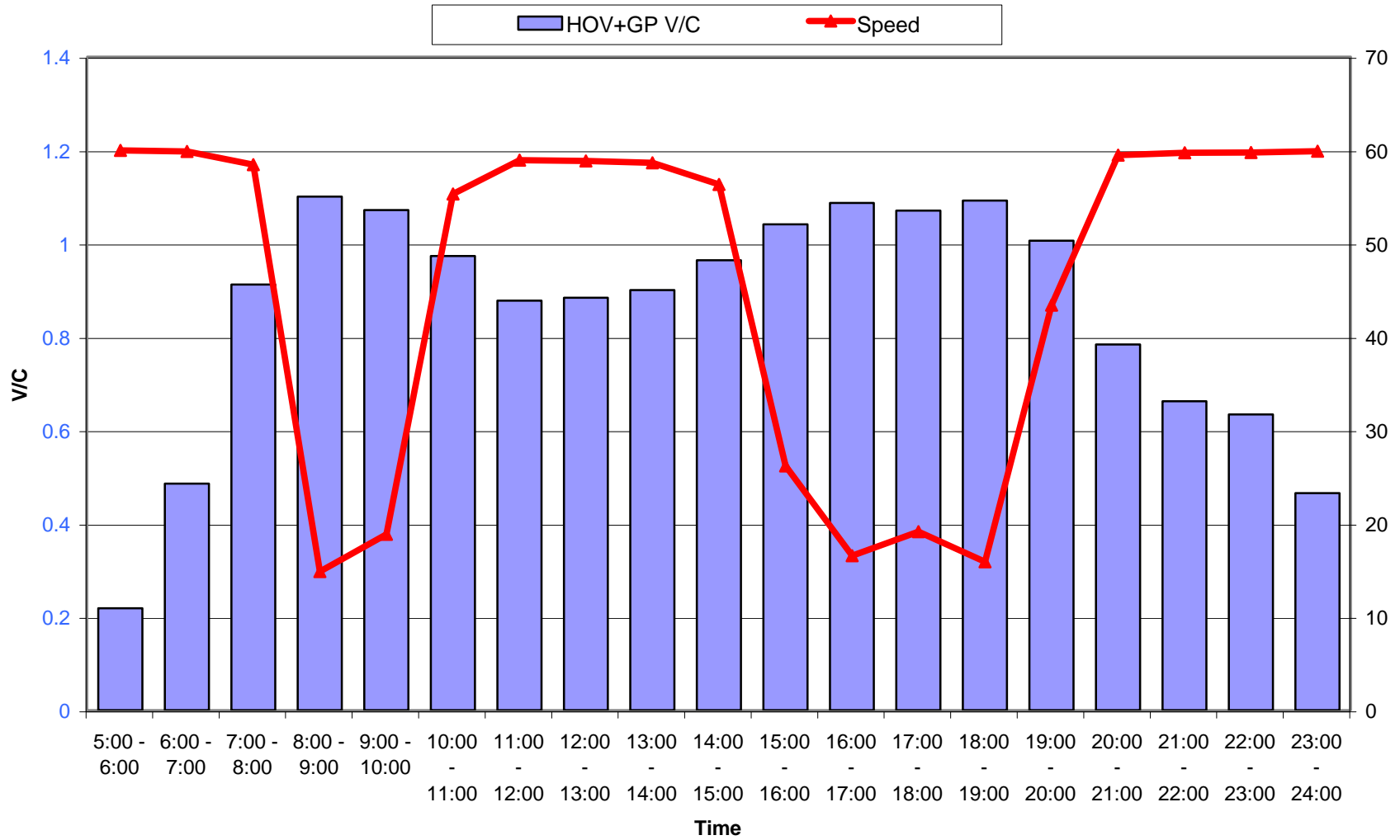
Value pricing has an impact on the V/C ratios and operating speeds on SR 520. Tolls on SR 520 and I-90 will provide a 15% to 24% improvement in V/C ratios accompanied by improved operating speeds on the general purpose lanes. On the other hand, In general, the improvement to V/C ratios and operating speeds on the SR 520 corridor varies with the level of congestion experienced. In other words, the greater the congestion is during peak periods (high V/C ratios and low speeds) under “No Toll” conditions, the larger the resulting change in V/C ratios and operating speeds from the introduction of tolls.



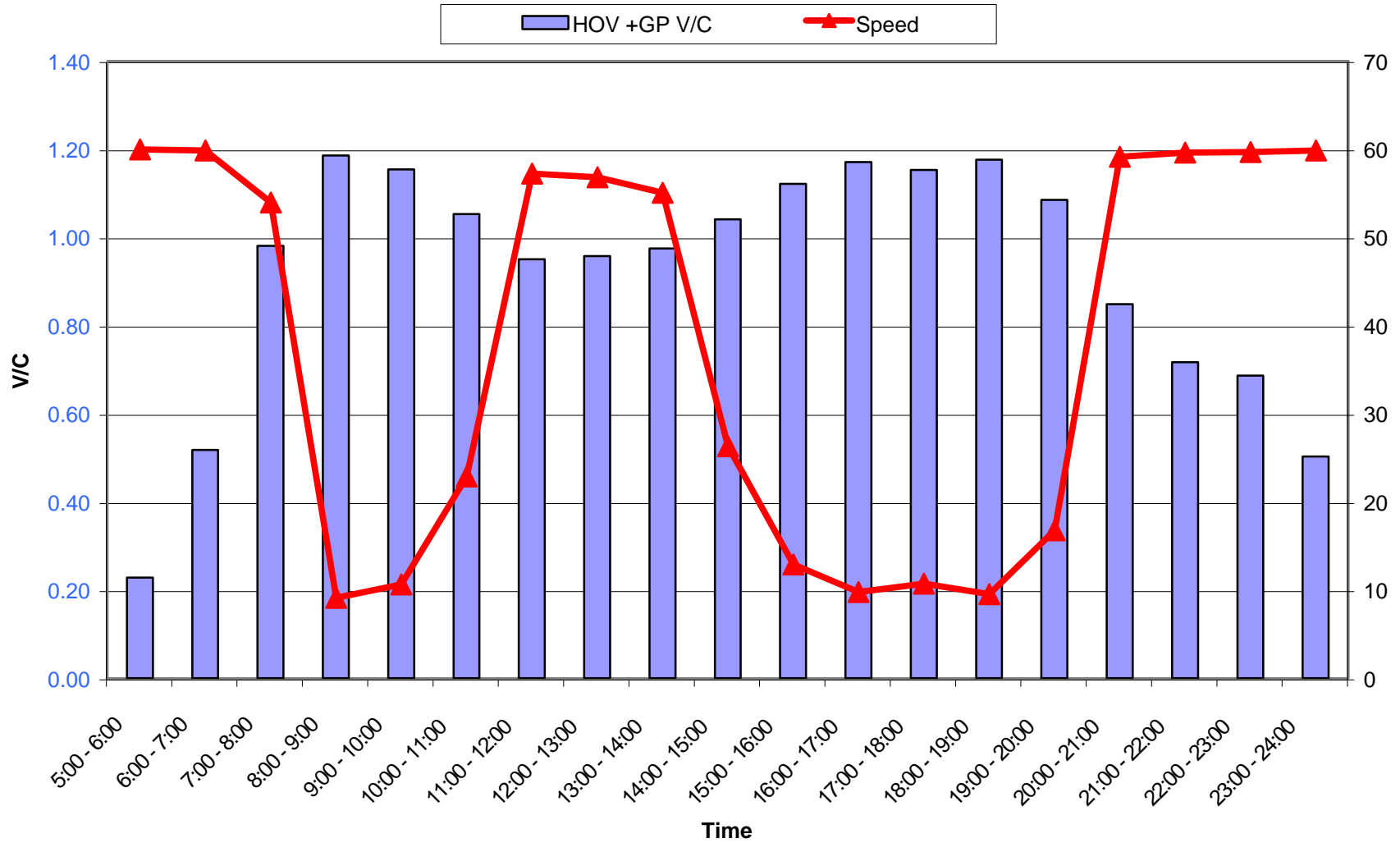
**Figure 9**  
**Year 2030 Mid-Lake SR-520 V/C Ratio and Speed**  
**4-Lane Alternative - No Toll**



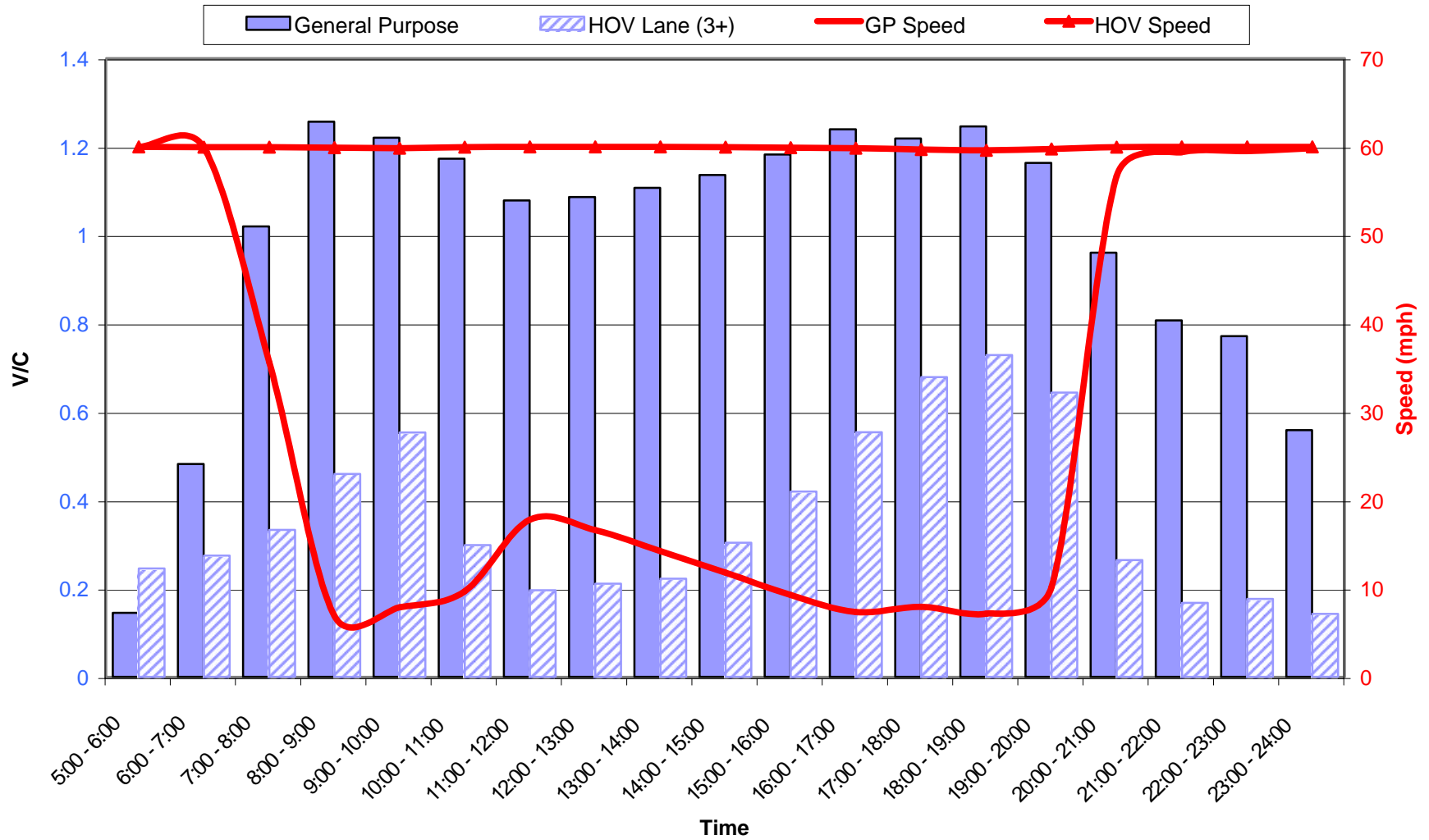
**Figure 10**  
**Year 2030 Mid-Lake SR-520 V/C Ratio and Speed**  
**4-Lane Alternative - Toll on SR-520**



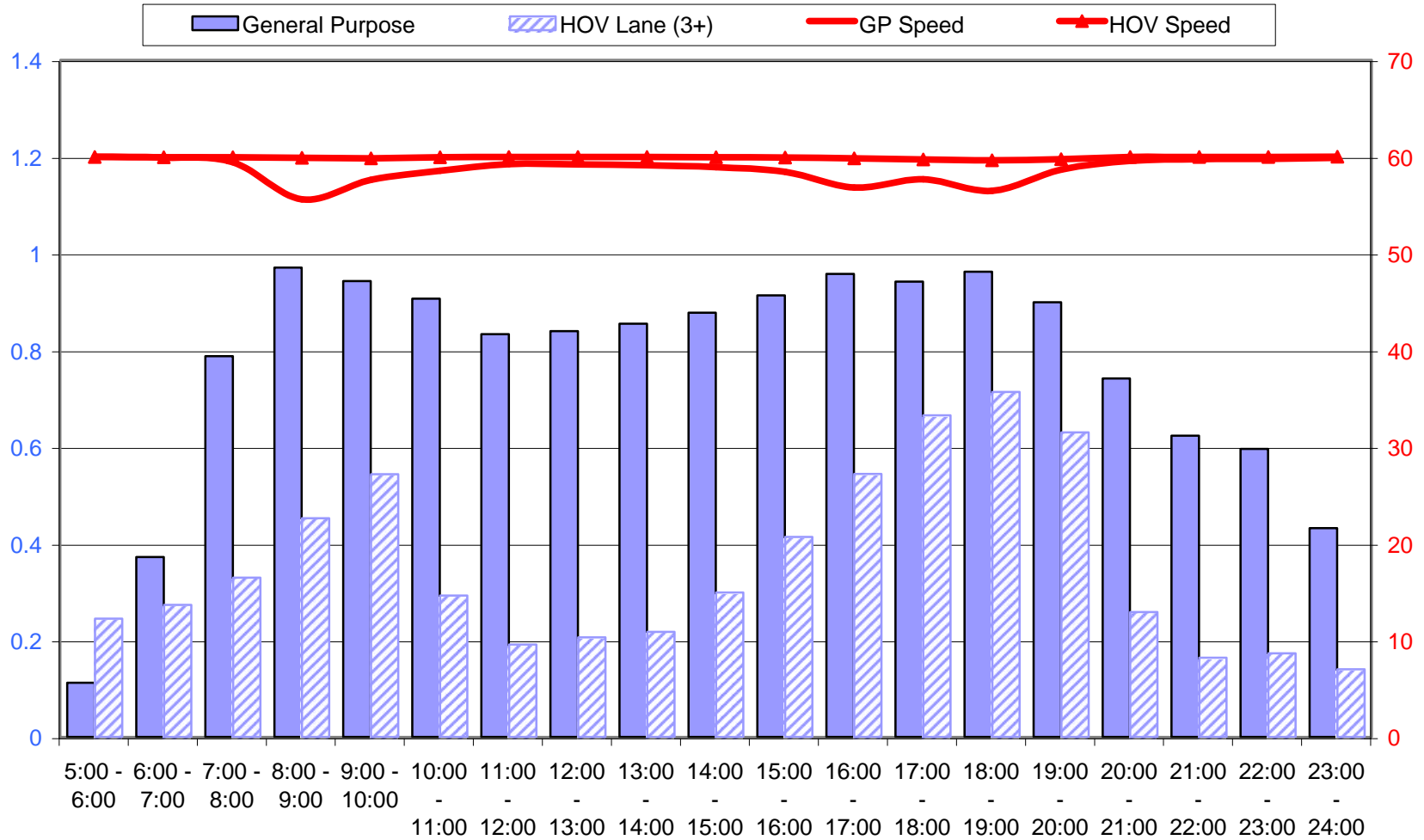
**Figure 11**  
**Year 2030 Mid-Lake SR-520 V/C Ratio and Speed**  
**4-Lane Alternative - Toll on SR-520 & I-90**



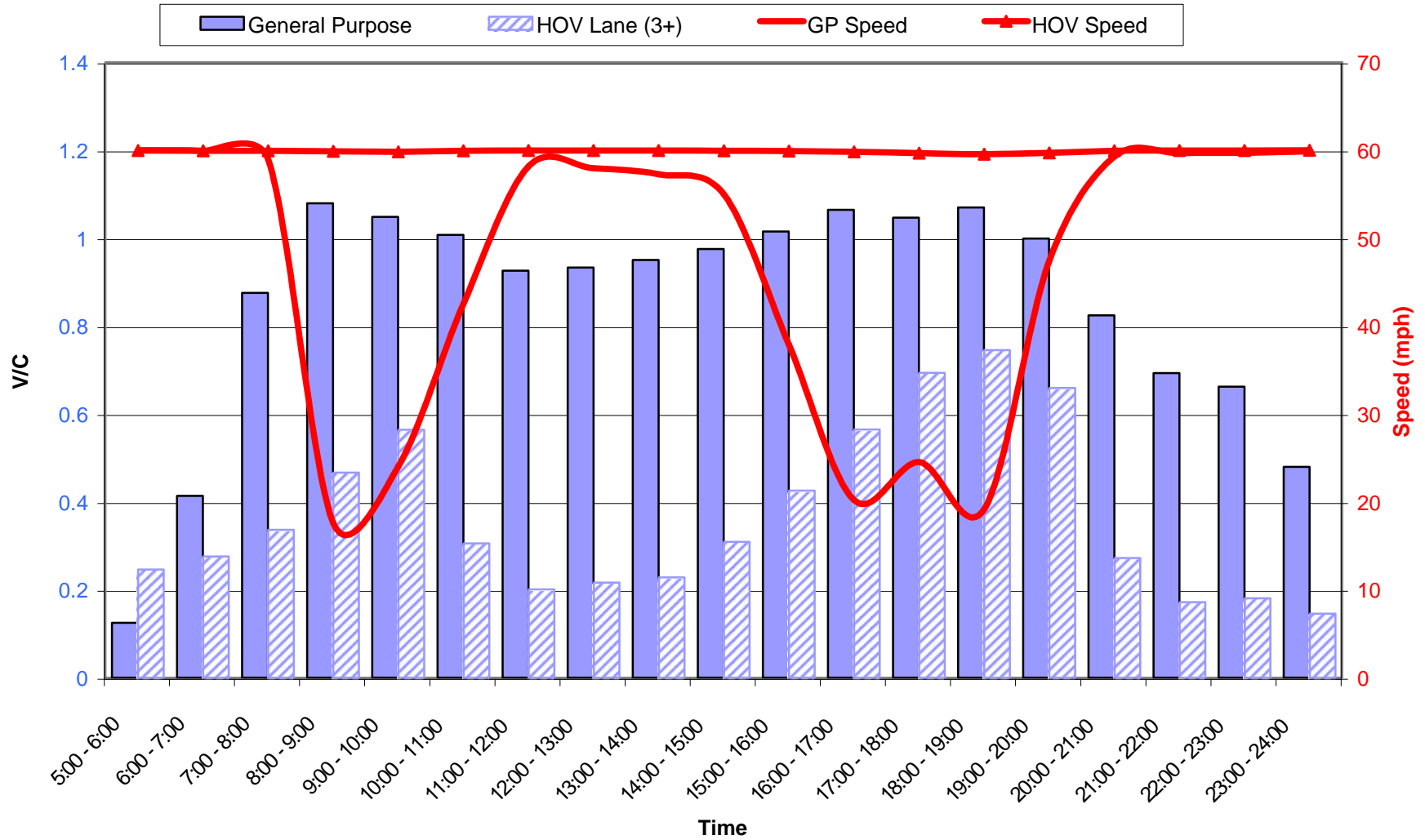
**Figure 12**  
**Year 2030 Mid-Lake SR-520 V/C Ratio and Speed**  
**6-Lane Alternative - No Toll**



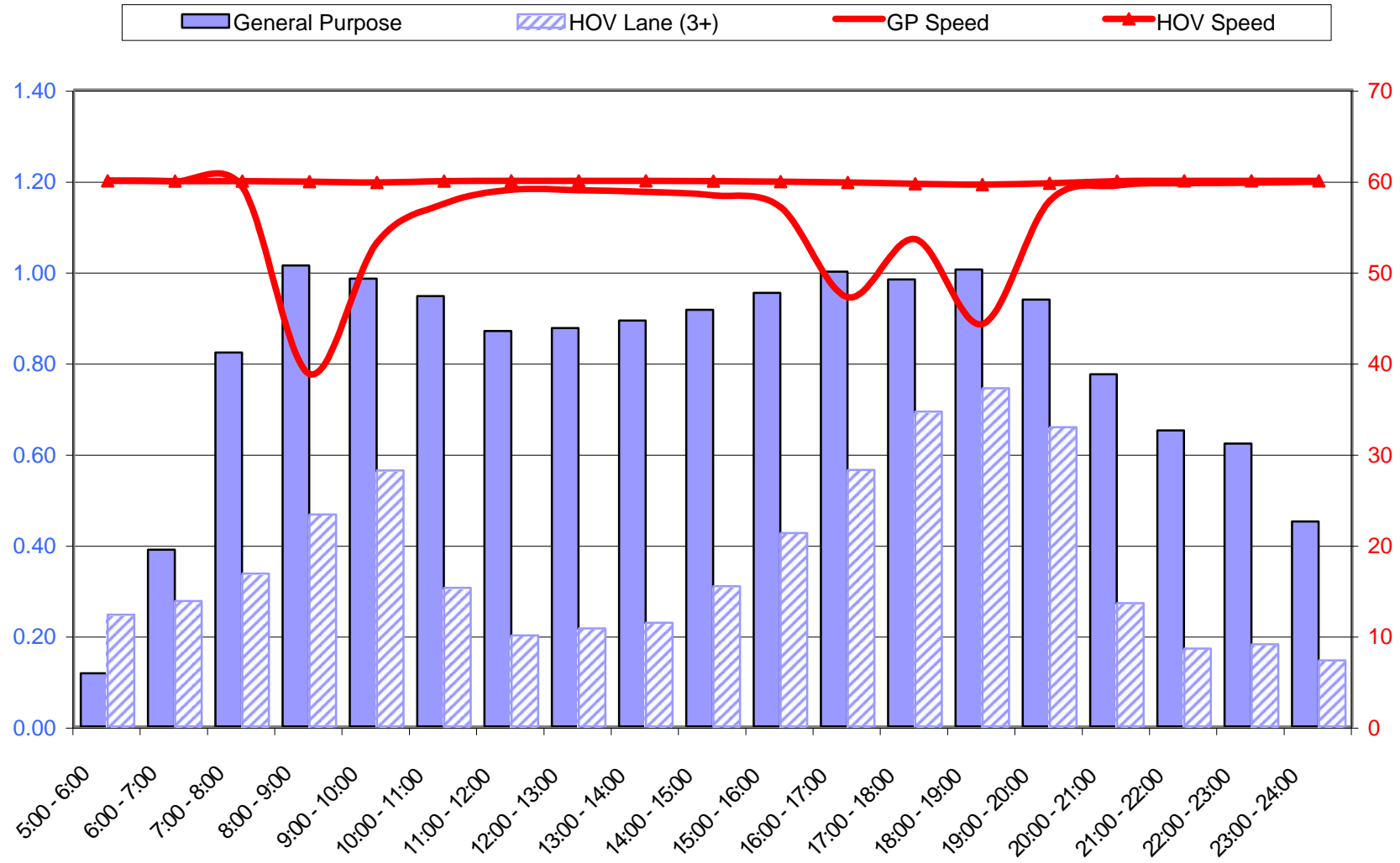
**Figure 13**  
**Year 2030 Mid-Lake SR-520 V/C Ratio and Speed**  
**6-Lane Alternative - Toll on SR-520**



**Figure 14**  
**Year 2030 Mid-Lake SR-520 Volume to Capacity Ratio**  
**6-Lane Alternative - Toll on SR-520 & I-90**

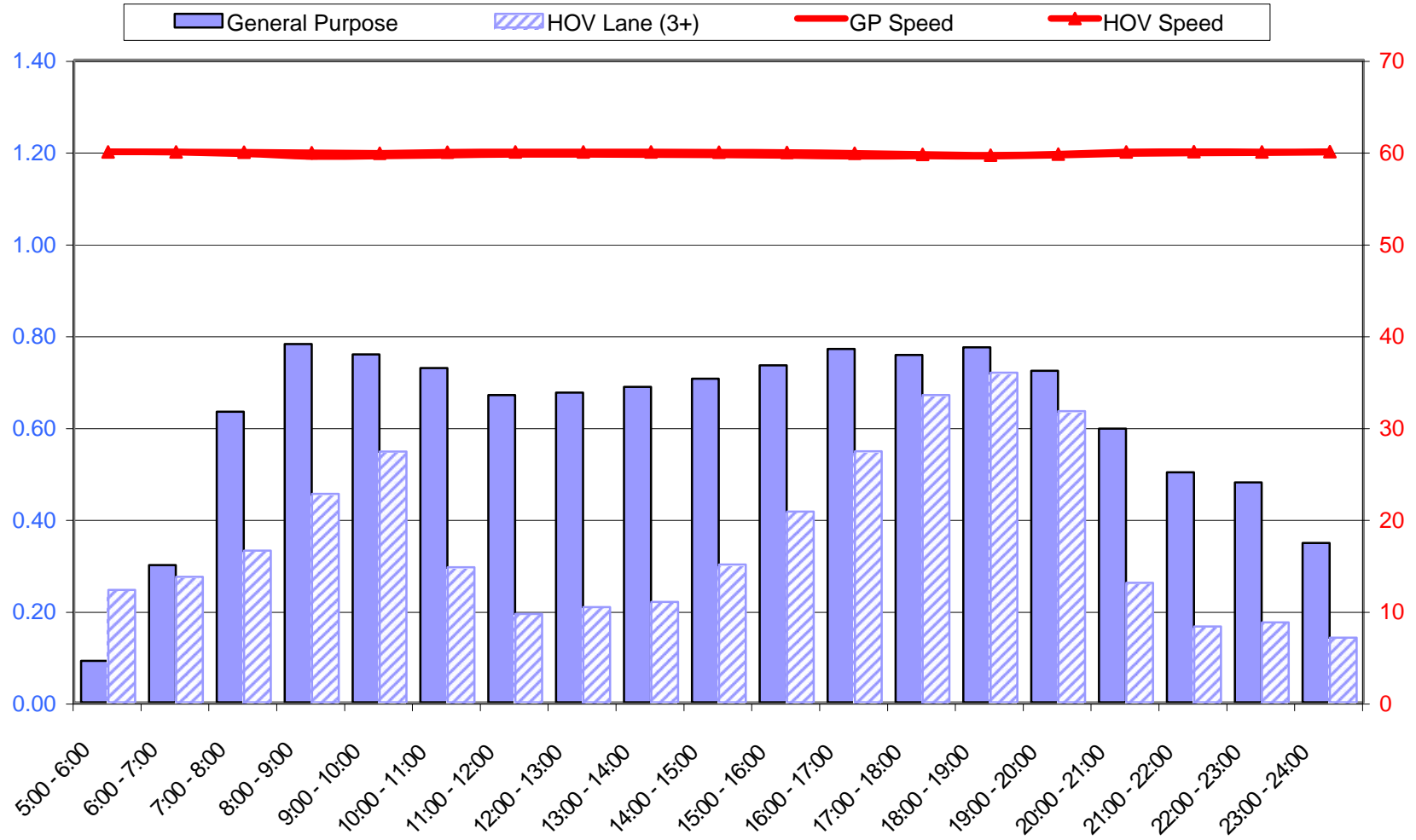


**Figure 15**  
**Year 2030 Mid-Lake SR-520 V/C Ratio and Speed**  
**8-Lane Alternative - No Toll**

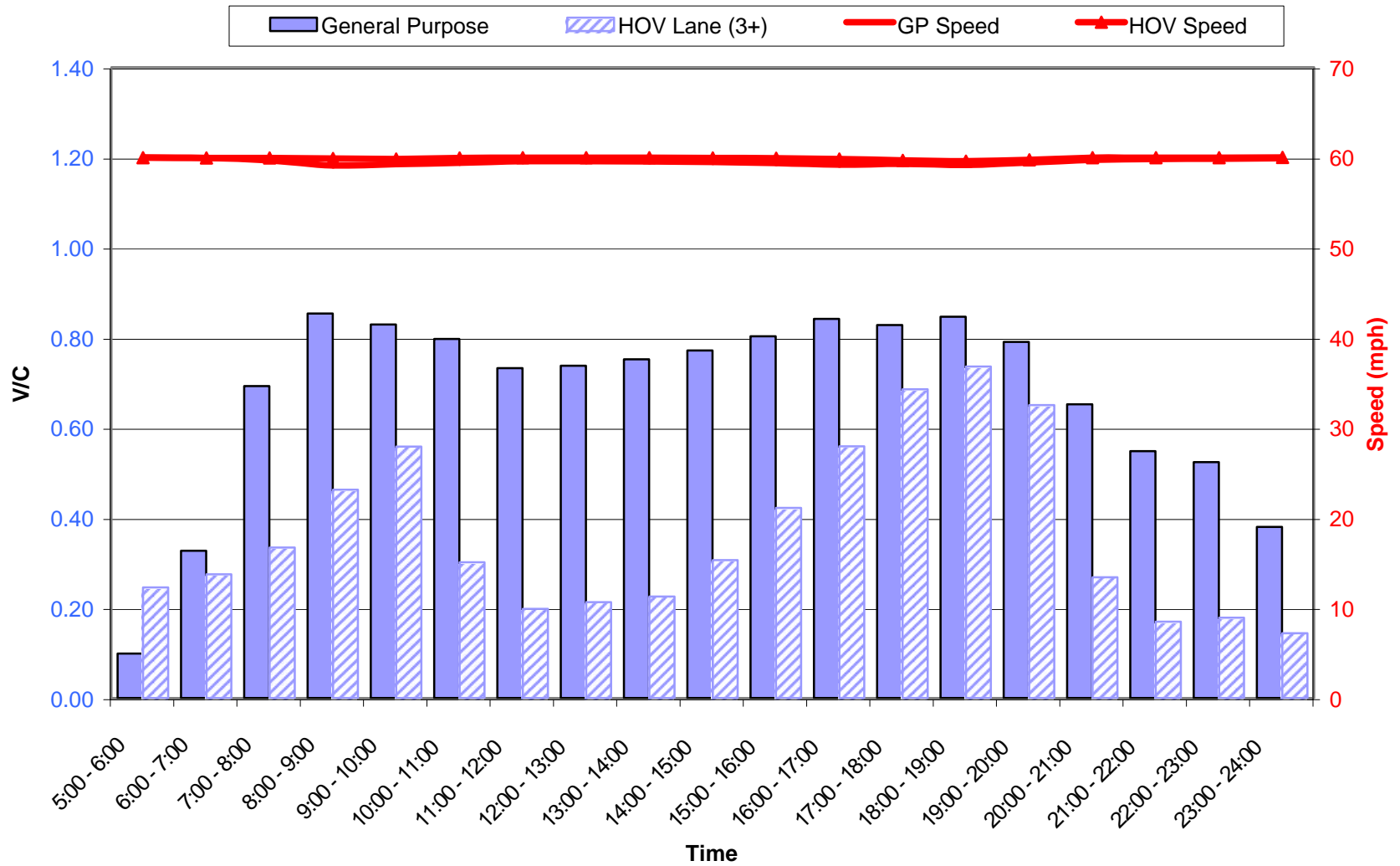




**Figure 16**  
**Year 2030 Mid-Lake SR-520 V/C Ratio and Speed**  
**8-Lane Alternative - Toll on SR-520**



**Figure 17**  
**Year 2030 Mid-Lake SR-520 V/C Ratio and Speed**  
**8-Lane Alternative - Toll on SR-520 & I-90**



## Mode Share

The mode share analysis focuses on the percentage of trips made by HOV, Non-HOV, and Transit modes for each of the 4, 6, and 8 Lane alternatives. This information is derived from the PSRC model person trip forecasts, and is provided in detail in the Appendix to this memorandum. Table 4 provides a summary of the modal shifts resulting from the application of tolls to cross-Lake Washington trips.

**Table 4: 1998 and 2030 Daily Mode Shares on SR 520  
With and Without Toll**

Alternative	HOV Trips	Transit Trips	Non-HOV Trips
Existing (1998)	2.0 percent	6.0 percent	92.0 percent
4 Lane Alternative (2030):			
– No Toll	10.9 percent	15.5 percent	73.6 percent
– Toll on SR 520	11.7 percent	21.1 percent	67.2 percent
– Toll on SR 520 & I-90	9.3 percent	20.2 percent	70.5 percent
6 Lane Alternative (2030):			
– No Toll	14.2 percent	18.5 percent	67.3 percent
– Toll on SR 520	18.3 percent	24.0 percent	57.7 percent
– Toll on SR 520 & I-90	17.2 percent	22.2 percent	60.6 percent
8 Lane Alternative (2030):			
– No Toll	12.2 percent	16.3 percent	71.5 percent
– Toll on SR 520	16.3 percent	20.7 percent	63.0 percent
– Toll on SR 520 & I-90	15.1 percent	19.4 percent	65.5 percent

### *Observations – Toll on SR 520 Only*

With tolls on SR 520, HOV trips increase by 1% to 4%, and transit trips increase by 4% to 6%, compared to 2030 conditions without tolls. As shown in Table 4, the highest mode shift of almost 10% (4% HOV and 5.5% Transit) occurs with the 6 Lane alternative, while the 8 Lane and 4 Lane alternatives show modal shifts of 8.50% and 6% respectively.

### *Observations – Toll on SR 520 and I-90*

When both SR 520 and I-90 are tolled, the response to modal shifts is lower than that resulting from when only SR 520 is tolled. As shown in Table 4, the 6 Lane alternative still has the highest mode shift of about 6.50% (3% HOV and 3.5% Transit), while the 8 Lane and 4 Lane alternatives show modal shifts of 6% and 3% respectively, compared to 2030 conditions without tolls.

### *Summary*

The introduction of value pricing on SR 520 and I-90 result in increases in HOV and transit trips crossing Lake Washington. The largest mode shift of 6% to 10% from non-HOV modes to HOV and transit modes is observed under the 6 Lane alternative, while the 8 and 4 Lane alternatives show mode shifts ranging between 8.5% and 3.0%, compared to 2030 conditions without tolls.



## Evaluation of the Managed Lanes Alternative

The following discussion presents the results from modeling the 8 Lane - Managed Lanes alternative. The performance of the Managed Lane alternative in comparison to the 8 Lane Base alternative (without toll) is presented below. This includes an analysis of the travel demand and traffic operations, i.e., V/C ratios and speeds on the SR 520 corridor.

The 8 Lane – Managed Lanes alternative as illustrated in Figure 18, consists of 4 general purpose lanes and 4 HOV lanes along the SR 520 corridor. The management component of this alternative relates primarily to managing access to the HOV lanes. This alternative provides free access to all HOV 3+ and transit users along the corridor, as well as, limited access to HOV 2 users. HOV 2 users will pay a toll to access the managed lanes at the following locations:

- Montlake Blvd.
- Bellevue Way/104<sup>th</sup> Avenue NE (direct HOV access ramps)
- I-405 (via freeway-to-freeway HOV ramps)
- Vicinity of NE 32<sup>nd</sup> Street (direct HOV access ramps near Overlake)
- SR 202 (east terminus)

These access points to the managed lanes were selected primarily because they serve as gateways to key activity centers (University of Washington and Bel-Red Overlake area), as well as direct access points for transit to access and egress the corridor. In addition, an HOV slip ramp to/from the mainline was assumed between 84<sup>th</sup> Avenue NE and 92 Avenue NE.

The extent of the analysis is limited to the evaluation of cross-Lake Washington traffic patterns on SR 520 across the following four screenline locations:

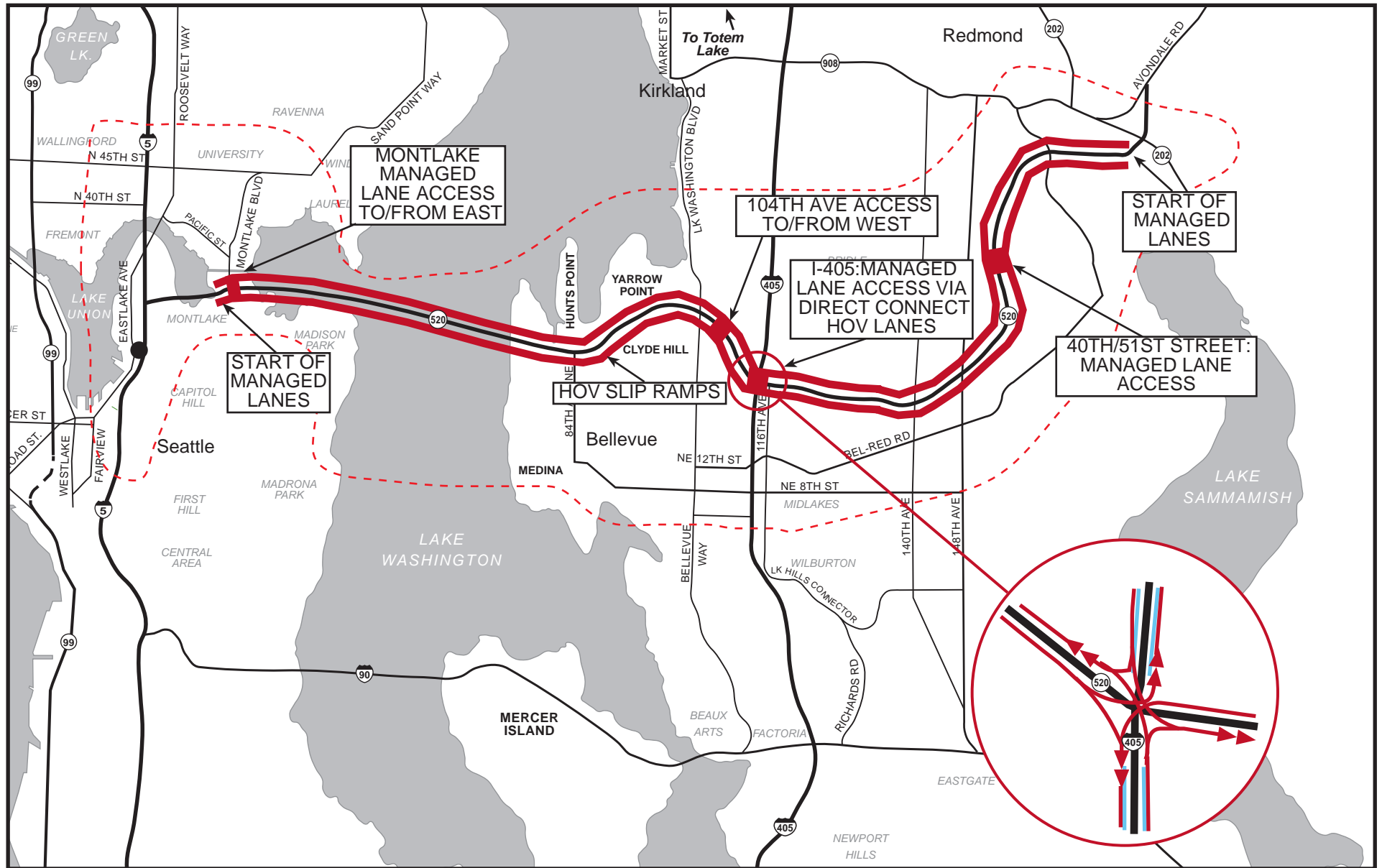
- Lake Washington Bridge
- East of Bellevue Way NE and West of I-405
- East of I-405 and West of 124<sup>th</sup> Avenue NE
- North of NE 51<sup>st</sup> Street and West of W. Lake Sammamish Parkway

### Travel Demand

The vehicle travel demand at four locations along the SR 520 corridor is shown in Table 5. The table compares the AM and PM peak periods, off-peak period, and daily vehicle trips across four screenlines from the Managed Lane alternative against the 8 Lane Base alternative. A general observation is that while vehicle throughput in the managed HOV lanes increased across all four screenlines, the demand on the mainline decreased. This is primarily due to the conversion of 2 general purpose lanes from the 8 Lane Base alternative to HOV and transit only lanes in the 8 Lane - Managed Lanes alternative.

HOV travel demand showed significant increases across all the screenlines, with the highest increases of nearly 300% being recorded on the 2 screenlines west of I-405, and the screenline at NE 51<sup>st</sup> Street (Redmond). Non-HOV travel demand showed significant decreases of nearly 20% across the 2 screenlines west of I-405, and about 10% across the NE 51<sup>st</sup> Street screenline.





## Trans-Lake Washington Project

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- Study Area Boundary
- Access Locations
- Managed Lanes
- HOV Lanes
- GP Lanes

**Figure 18**  
**Managed Lanes Access Points**

**Table 5: Vehicle Travel Demand – Managed Lane Alternative**

on SR 520 Lake Washington Bridge								
	SR 520 - 8 Lane Alternative (with Managed Lanes)			SR 520 - 8 Lane Alternative (without Managed Lanes)			Change in Total Volume	Percent Change from PA
	Mainline	Managed Lanes	Total	GP Lane	HOV (3+) Lane	Total		
AM Peak (3 hours)	27,400	11,500	38,900	35,200	4,200	39,400	(500)	-1%
PM Peak (3 hours)	34,600	10,300	44,900	45,100	3,400	48,500	(3,600)	-7%
Off Peak (18 hours)	85,700	15,400	101,100	106,300	5,100	111,400	(10,300)	-9%
Total Daily (24 hours)	147,700	37,200	184,900	186,600	12,700	199,300	(14,400)	-7%
on SR 520 East of Bellevue Way NE and West of I-405 (Kirkland)								
	SR 520 - 8 Lane Alternative (with Managed Lanes)			SR 520 - 8 Lane Alternative (without Managed Lanes)			Change in Total Volume	Percent Change from PA
	Mainline	Managed Lanes	Total	GP Lane	HOV (3+) Lane	Total		
AM Peak (3 hours)	23,000	8,500	31,500	27,900	3,000	30,900	600	2%
PM Peak (3 hours)	28,800	8,300	37,100	37,200	2,800	40,000	(2,900)	-7%
Off Peak (18 hours)	70,200	12,200	82,400	86,900	4,200	91,100	(8,700)	-10%
Total Daily (24 hours)	122,000	29,000	151,000	152,000	10,000	162,000	(11,000)	-7%
on SR 520 East of I-405 and West of 124th NE (Bellevue)								
	SR 520 - 8 Lane Alternative (with Managed Lanes)			SR 520 - 8 Lane Alternative (without Managed Lanes)			Change in Total Volume	Percent Change from PA
	Mainline	Managed Lanes	Total	GP Lane	HOV (3+) Lane	Total		
AM Peak (3 hours)	20,700	4,700	25,400	22,200	3,200	25,400	-	0%
PM Peak (3 hours)	26,800	3,800	30,600	31,000	2,600	33,600	(3,000)	-9%
Off Peak (18 hours)	62,800	5,900	68,700	72,300	4,200	76,500	(7,800)	-10%
Total Daily (24 hours)	110,300	14,400	124,700	125,500	10,000	135,500	(10,800)	-8%
On SR 520 North of NE 51st and West of W Lake Sammamish (Redmond)								
	SR 520 - 8 Lane Alternative (with Managed Lanes)			SR 520 - 8 Lane Alternative (without Managed Lanes)			Change in Total Volume	Percent Change from PA
	Mainline	Managed Lanes	Total	GP Lane	HOV (3+) Lane	Total		
AM Peak (3 hours)	29,700	4,100	33,800	32,900	1,600	34,500	(700)	-2%
PM Peak (3 hours)	38,500	3,800	42,300	43,600	1,200	44,800	(2,500)	-6%
Off Peak (18 hours)	99,000	5,300	104,300	107,500	2,000	109,500	(5,200)	-5%
Total Daily (24 hours)	167,200	13,200	180,400	184,000	4,800	188,800	(8,400)	-4%



The total travel demand across all four screenlines as shown in Table 6 for the AM, PM and off-peak periods, also shows a general decrease of about 4% to 8% in total trip activity on the SR 520 corridor. This primarily reflects the reduction in the overall demand for non-HOV trips along the corridor due to the decrease in general purpose capacity caused by the conversion of 2 general purpose lanes to 2 Managed lanes.

**Table 6: Comparison of 2030 Daily Vehicle Trips**

Screenline	8 Lane Base Alternative	8 Lane - Managed Lane Alternative	Difference
Lake Washington Bridge	199,300	184,900	- 14,400
East of Bellevue Way NE and West of I-405	162,000	151,000	- 11,000
East of I-405 and West of 124 <sup>th</sup> Avenue NE	135,500	124,700	- 10,800
North of NE 51 <sup>st</sup> and West of W. Lake Sammamish Pkwy.	188,800	180,400	- 8,400

### Volume to Capacity (V/C) Ratios and Speeds

Figures 19 and 20 show the operating conditions on the SR 520 bridge for the 8 Lane Base alternative and the 8 Lane - Managed Lanes alternatives respectively.

### Calculation of V/C Ratios and Speeds

The V/C ratios and speeds for the SR 520 bridge under the 8 Lane – Managed Lanes alternative was calculated based on the following assumptions:

- 2030 daily traffic forecasts from the 8 Lane – Base Alternative and the 8 Lane – Managed Lanes alternatives served as the starting point for this analysis.
- Existing daily traffic volume distribution on SR 520 (near 76<sup>th</sup> Street) was used to generate the future hourly traffic volume distribution for the general purpose lanes and the HOV lanes.
- The 8 Lane alternative assumes a lane capacity of 2200 vehicles per hour per lane. The higher capacity per lane was assumed to take into account the two additional lanes that are being considered on the SR 520 bridge, in addition to the standard improvements to shoulder width, lane width, and improved sight distance.
- A HOV lane capacity of 1800 vehicles per hour.
- Buses were converted to PCE and added to the HOV lane volumes.
- A PCE conversion factor of 3.1 was used. This assumes 50 percent of the buses to be articulated



with a PCE of 4 and the remainder to be single unit buses with a PCE factor of 2.2.

- 2030 general purpose traffic volumes were converted to PCEs assuming 5% heavy vehicles with a PCE factor of 2.2.

The 8 Lane - Base alternative (Figure 19) shows the general purpose lanes during peak periods to be operating at a V/C ratio of 1.0 with operating speeds ranging between 40 mph and 50. While, the HOV lanes operate at V/C ratios ranging between 0.40 and 0.75 and an average speed of 60 mph.

With the conversion of 2 general purpose lanes to 2 HOV lanes in the Managed Lanes alternative, the travel conditions during the peak periods on the general purpose lanes deteriorate to V/C ratios of 1.00 to 1.10, with speeds dropping down to the 20mph – 25mph range. The HOV lanes still continue to operate under uncongested conditions – V/C ratios of 0.40 to 0.80 and an average speed of 60 mph (Figure 20).

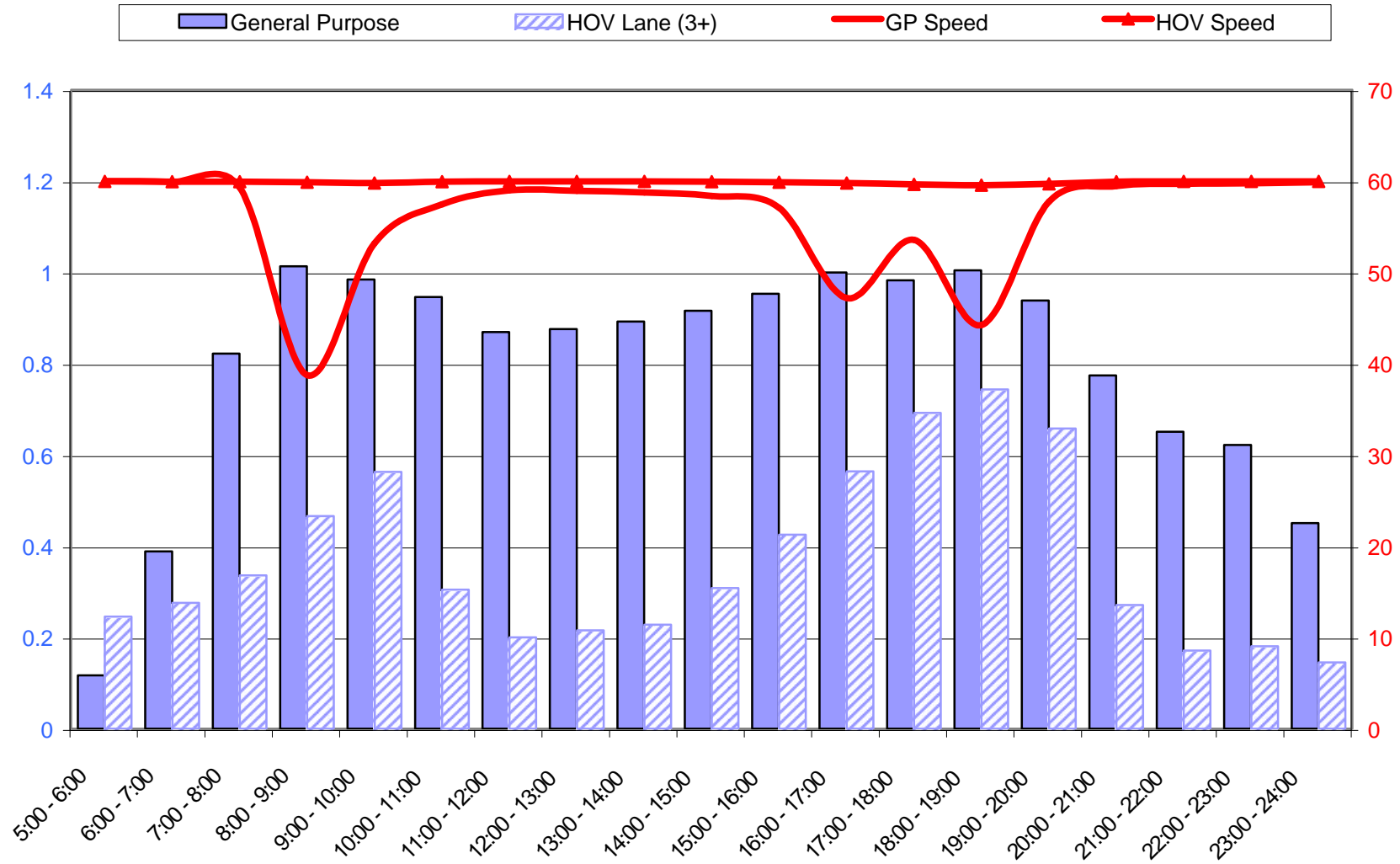
### ***Summary***

The demand for non-HOV trips on the Trans-Lake corridor is considerably higher than for HOV trips. The provision of additional HOV capacity on the corridor with limited access points to HOV 2 users does create a large shift of non-HOV trips to HOV trips. However, our analysis shows a significant amount of capacity to be still available in the Managed Lanes. Providing full access to HOV 2 users beyond just those allowed in the Managed Lanes alternative could lead to additional HOV 2 trips diverting from the general purpose lanes to the HOV lanes. This could result in improving operating conditions on the general purpose lanes, while providing for a more balanced flow of non-HOV and HOV trips along the corridor. Another possibility for using the excess capacity on the managed lanes, as well as balance HOV and non-HOV flows would be to allow SOV to pay a fee for using the uncongested managed lanes.

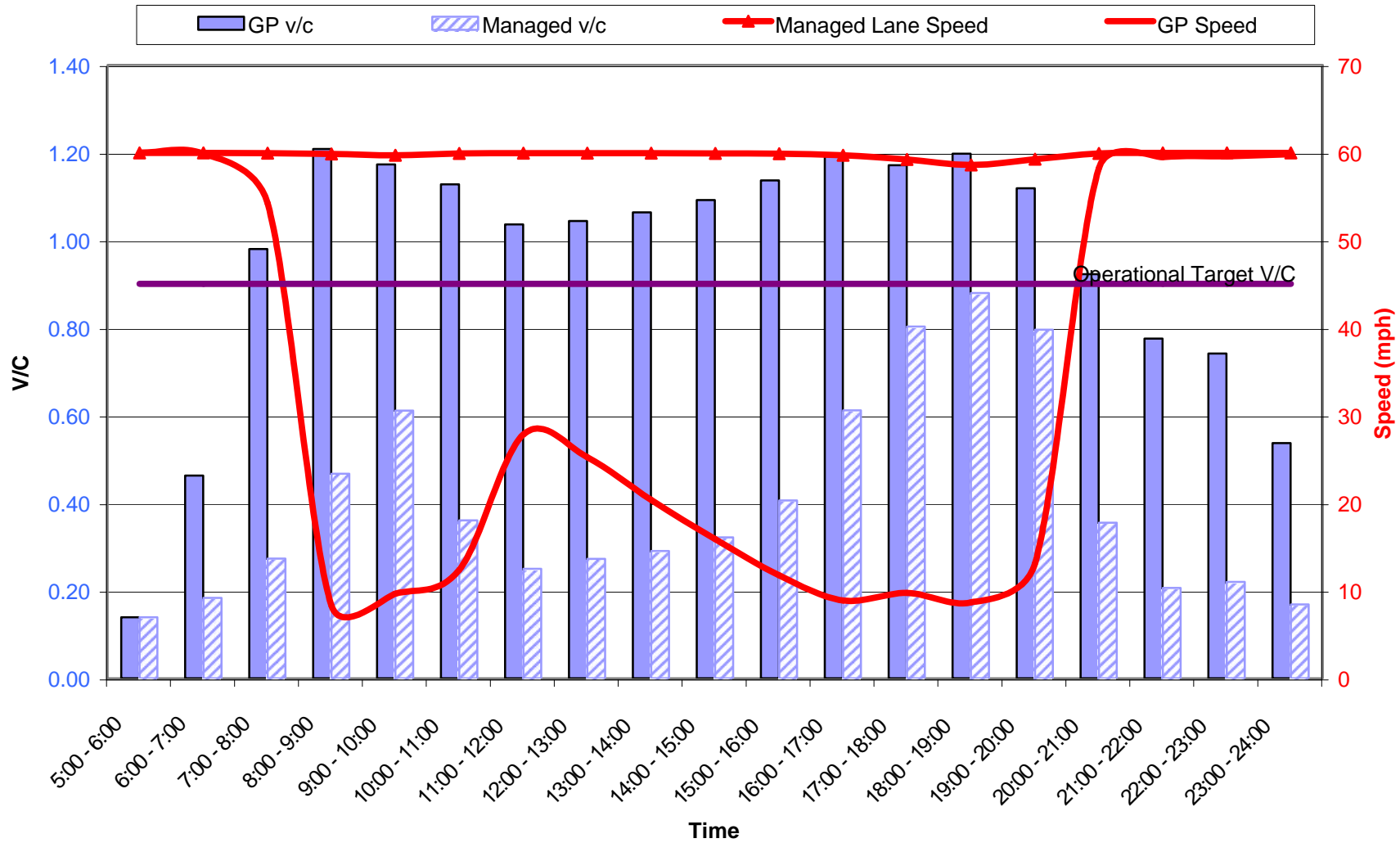




**Figure 19**  
**Year 2030 Mid-Lake SR-520 V/C Ratio and Speed**  
**8-Lane Alternative - No Toll**



**Figure 20**  
**Year 2030 Mid-Lake SR-520 V/C Ratio and Speed**  
**8-Lane Alternative - Managed Lanes**



## SUMMARY OF FINDINGS – TRANS-LAKE PRICING ANALYSIS

### *Pricing Assumptions - Base Value of Time:*

- Average peak period toll for one-way trip on the full length of SR 520 in 2014: \$1.15 to \$1.80
- Average peak period toll for one-way trip on the full length of SR 520 in 2030: \$1.41 to \$2.43
- Average peak period toll for one-way trip on the full length of I-90 in 2014: \$0.80 to \$1.20
- Average peak period toll for one-way trip on the full length of I-90 in 2030: \$0.93 to \$1.73

### *Pricing Assumptions - Low Value of Time:*

- Average peak period toll for one-way trip on the full length of SR 520 in 2014: \$0.77 to \$1.15
- Average peak period toll for one-way trip on the full length of SR 520 in 2030: \$0.90 to \$1.54
- Average peak period toll for one-way trip on the full length of I-90 in 2014: \$0.53 to \$0.80
- Average peak period toll for one-way trip on the full length of I-90 in 2030: \$0.67 to \$1.20

### *Findings from Value Pricing on SR 520:*

The following summary observations can be made based upon the modeling and traffic analyses conducted in this study:

- Value pricing has an overall impact on the travel demand, travel patterns, and traffic operations in the Trans-Lake corridor.
- The travel demand analyses show decreases in person and vehicle throughput when pricing is introduced to the Trans-Lake corridor. The decreases in person throughput are in the range of 10 to 15 percent, while reductions in vehicle throughput are around 20 percent.
- The traffic analysis shows improvements to operating conditions on the Lake Washington bridge. On average, the V/C ratios on the general purpose lanes along the corridor improve by 25 percent, accompanied by increases in operating speeds to reflect uncongested flows on the general purpose lanes on SR 520, while HOV lanes continue to operate at uncongested speeds.
- The mode share analyses show HOV and transit trips to increase by 6 to 10 percent when pricing is introduced to the corridor.
- An analysis of the travel patterns shows diversion of traffic resulting from peak period value pricing. The reductions in vehicular traffic on SR 520, results in diversion of traffic to the I-90 and SR 522 corridors, and on to local eastside arterials:
  - 20 percent decrease in traffic on SR 520
  - 8 to 11 percent increases in traffic on I-90
  - 4 to 6 percent increase in traffic on SR 522
  - 3 to 5 percent increase in traffic on arterial roadways in the communities of Seattle, Bellevue, Kirkland, Redmond, and the Points Communities.



### ***Findings from Value Pricing on SR 520 and I-90:***

While, most of the trends are similar to that observed from value pricing on SR 520 only, the changes in travel patterns and traffic diversion impacts are of a lower order.

- Pricing does impact the travel demand, travel patterns, and traffic operations in the Trans-Lake corridors.
- The travel demand analyses show decreases in person and vehicle throughput when pricing is introduced to the Trans-Lake corridors. While the decreases in person throughput are in the range of 5 to 11 percent, reductions in vehicle throughput range from 12 to 15 percent.
- While, the traffic analysis shows improvements to operating conditions on SR 520 and I-90, SR 522 shows a degradation in operating conditions. On average, the V/C ratios on the general purpose lanes (on SR 520 and I-90) along the corridor improve by 20 percent, accompanied by increases in operating speeds on the general purpose lanes. HOV lanes continue to operate at uncongested speeds on both SR 520 and I-90. Operating conditions on SR 522 deteriorate the most when both SR 520 and I-90 are priced.
- The mode share analysis show HOV and transit trips to increase in the range on 3 to 8 percent when pricing is introduced on both SR 520 and I-90.
- An analysis of the travel patterns shows the following displacement of traffic resulting from pricing travel on SR 520 and I-90. In general, the reduction in daily trips on SR 520 and I-90, results in traffic being diverted to the SR 522 corridor, and on to local eastside arterials:
  - 14 to 16 percent decrease in traffic on SR 520
  - 6 to 12 percent decrease in traffic on I-90
  - 7 to 17 percent increase in traffic on SR 522
  - 5 to 10 percent increase in traffic on arterial roadways in the communities of Seattle, Bellevue, Kirkland, Redmond, and the Points Communities.



## General Conclusions on Pricing and Managed Lanes

The following general conclusions on travel demand and traffic operations can be made with respect to the pricing and managed lanes concepts analyzed in this study.

- The 15 to 20 percent reduction in vehicular trips in response to pricing is consistent with the theory and observations from other value pricing studies. This results in overall improvements to the traffic flow and operations along the Trans-Lake corridor. As a point of reference, it is worth noting that this reduction in vehicle trips is comparable to the 16% increase in daily traffic observed when tolls were removed from SR 520 in 1979.
- Pricing non-HOV trips on the Trans-Lake corridors results in increased carpooling and transit trips across Lake Washington. The increases range between 3 and 10 percent.
- Pricing has an impact on travel patterns across Lake Washington. The largest displacement of trips occurs when both SR 520 and I-90 are priced – increases of 7 to 17 percent on SR 522, and 5 to 10 percent on Seattle and Eastside arterials. Traffic diversions resulting from pricing only the Trans-Lake corridor, show increases of 4 to 6 percent on SR 522, 3 to 5 percent increase on Seattle and Eastside arterials, and 8 to 11 percent on I-90.
- Congestion levels can be improved using pricing strategies during peak periods of travel.
- The revenue estimates for a stand-alone SR 520 toll (value priced) facility, in inflated year of collection dollars are:

Year 2014: \$17.7 M - \$30.9 M

Year 2030: \$38.4 M - \$66.7 M

- Managed lanes provide improved corridor speeds, in comparison to the general purpose lanes.
- Managed lanes operating on access restrictions and occupancy requirements alone are forecast to have excess or “un-used” capacity that could be allocated to other users. Based on the model results, there is enough capacity to allow low occupant vehicles (i.e., SOV and HOV 2 users) to use the managed lanes for a fee. This would result in increased person throughput when compared to the 8 Lane Base scenario.
- Managed lanes could provide better person throughput when compared to an HOV 3+ concept, while maintaining the same vehicle throughput.



## RECOMMENDED NEXT STEPS

Since the initial results from the value pricing and managed lanes concepts tested show promise in reducing congestion and improving traffic operations in the Trans-Lake corridor, there is merit in continuing to build upon what has already been tested. The following additional steps are recommended towards this end:

- The regional PSRC travel demand models are currently in the process of being updated. It is expected that the key methodological components of this model, i.e., trip distribution, mode choice, and time-of-day analysis models will be replaced once the ongoing PSRC Model Improvement Program is successfully completed in late-Fall. It is recommended that value pricing and managed lanes concepts be tested with the Preferred Alternative using the updated regional models.
- The value pricing concepts tested in this study assumed tolls on SR 520 and I-90 only. The Washington Department of Transportation (WSDOT) has embarked on a region-wide analysis of pricing. It is recommended that the results from this study be compared with the regional analysis to better understand the travel demand interplay between pricing on one or two corridors, versus a region-wide pricing approach.
- Another option for furthering the value pricing concept would be to develop a cooperative regional pricing plan, wherein the Trans-Lake corridor could serve as a pilot demonstration project.
- Any further analysis of the value pricing concept should include a detailed traffic diversion analysis that identifies the relative impacts of traffic diversion on local arterials.
- The value pricing methodology currently being used does not include a discrete toll model. Hence the estimates of toll rates from this analysis should be viewed as a preliminary estimate of economically efficient toll rates based on managing travel demand. If value pricing is recommended for inclusion in the EIS, a more extensive effort will be required to collect appropriate survey data and develop a toll mode choice model. Such an effort is usually required for the development of investment-grade toll estimates.
- Any further analysis of the managed lanes concept should consider the potential for low occupant vehicles (i.e., SOV and HOV 2) to use the managed lanes for a fee.
- The managed lanes concept was only tested on SR 520. It is recommended that a system-wide analysis of the managed lanes concept be undertaken to fully understand how managed lanes on SR 520 would connect and operate with the managed lanes on I-405, I-90, and I-5.

